Analysis of the Failures along the Kuantan-Kerteh Railway Project

by

Ho Siew Chen

Dissertation submitted in partial fulfilment of
the requirements for the
Bachelor of Engineering (Hons)
(Civil Engineering)

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the

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UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

July 2006

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

HO SIEW CHEN

ABSTRACT

Kuantan-Kerteh Railway Project (KKRP) is a 72 km single track link owned by PETRONAS that provides a container shuttle service for refinery products in the fast-growing Eastern Corridor petrochemical hub. Upon completion, several failures, including slope stability, erosion and settlement have been noticed along several stretches of the project. As a result, the track is under-utilized and the speed of the train had to be lowered well below the design speed. An investigation was initiated by the owner to study this problem and to put forward counteractive actions. This study ultilised the Piezocone Penetration Test, and the Revised Universal Soil Loss Equation (RUSLE) for the assessment of soil profiling and erosion. In this report, the outcome of the investigation and suggested remedial actions between CH 26+325 to CH 27+000 are presented. Additionally, a feasibility study of the suggested remedial actions is also presented.

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CHAPTER 1 - INTRODUCTION

1.1 Background of Study

PETRONAS, the major investor in the number of petrochemical ventures recognizes the need for a good container port like Kuantan Port to be linked to Kerteh Petrochemical Integrated Complex, in order to facilitate traffic generated from the petrochemical ventures. Kuantan-Kerteh Railway Project (KKRP) is a 72 km single track link that provides a container shuttle service for refinery product in the fast-growing Eastern Corridor petrochemical hub (*See Appendix A*). Upon completion, several failures, including slope stability, erosion and settlement have been noticed along several stretches of the project. As a result, the track is under-utilized and the speed of the train had to be lowered well below the design speed. The analysis is to be conducted via engineering forensic approach

Forensic engineering is a multi-disciplinary procedure for investigating and reporting the cause of engineering problems. It is established on the scientific method which is fundamental to the solution of most engineering predicaments whether they are related to civil, structural, mining, mechanical, chemical, or other engineering fields. In this particular case, knowledge in the field of Geotechnical Engineering is essential.

The outcome of the investigative and assessment procedure is an analytical report which must deal with the facts and assumptions, provide a detailed analysis, and come to a conclusion that expresses opinion about cause of the casualty event, and propose a remedial action.

1.2 Problem Statement

Upon completion of the Kuantan-Kerteh Railway Project, several failures, including slope stability, erosion and settlement have been noticed along several stretches of the project. It is required to investigate the causes of such failures, and assesses the proposed remedial actions. It is crucial to demonstrate a high standard of care with the examination of the scene, collection of the available evidentiary data, and the interpretation and assessment of all the information, as every forensic engineering case has the potential of becoming the subject of an alternate dispute resolution (ADR) or lawsuit.

1.3 Objective and Scope of Study

The ultimate aim of the study is to propose remedial action to rectify failure along chainage 26+325 to chainage 27+000 of Kuantan-Kerteh Railway Project via forensic engineering approach. The scope of studies includes review and analyse testing performed along the stretch, to determine the mode of failure(s), to understand, review, analyse and compare suggested corrective actions in terms of feasibility and cost.

CHAPTER 2 - LITERATURE REVIEW AND THEORY

2.1 Piezocone Penetration Test

2.1.1 Introduction

A Cone Penetration Test (CPT) device consists in a cylindrical probe with a cone-shaped tip with different sensors that allow a real time continuous measurement of soil strength and characteristics by pushing it into the ground. According to *Bruce and Richard (1981),* "The Cone Penetration Test (CPT) provides data which may be viewed as an index to expected soil mechanical behaviors...usually correlates well with Unified Soil Classification System (USCS) indices, and that the CPT method provides a clearer overall picture of in situ conditions than available with other exploration methods."(p. 209).

According to Brouwer (2002), probing through weak ground to locate a firmer stratum has been practiced since 1917. Later in the year of 1932 the Cone Penetrometer Test (CPT) was introduced in Netherlands. The method has earlier been referred to as the static penetration test, quasi-static penetration test and Dutch sounding test. Existing CPT systems can be divided into three main groups:

i. Mechanical Cone Penetrometers
ii. Electric Cone Penetrometers
iii. Piezocone Penetrometers

Cone penetration test (CPT) provides nearly continuous readings with depth, potentially softer layers can be identified for companion drilling and sampling. Piezocone test, also known as Cone penetration test Piezocone (CPTU) is cone penetration tests (CPT) with additional measurement of the pore water pressure at one or several locations on the penetrometer surface. Cone penetration testing with pore water pressure measurements gives a more reliable determination of stratification and soil type than standard CPT. In addition, CPTU gives a better basis for interpretation of the results in terms of mechanical soil properties such as shear strength parameters, deformation and consolidation characteristics.

Cone penetrometer soundings are being employed with increasing regularity, especially in evaluation of soil liquefaction potential (Lew, 2001; Martin and Lew, 1999; Youd and Idriss, 1997; Robertson and Wride, 1997).

2.1.2 Mechanism of CPT

According to ASTM D-3441, adopted in 1974, the standardized Cone Penetrometer Test (CPT) involves pushing a 1.41-inch (35.8mm) diameter 55° to 60° cone through the underlying ground at a rate of 1 to 2 cm/sec.

CPT soundings can be very effective in site characterization, especially sites with discrete stratigraphic horizons or discontinuous lenses. Cone penetrometer testing is a valuable method of assessing subsurface stratigraphy associated with soft materials, discontinuous lenses, organic materials (peat), potentially liquefiable materials (silt, sands and granule gravel) and landslides.

Most of the commercially-available CPT rigs operate electronic friction cone and piezocone penetrometers, whose testing procedures are outlined in ASTM D-5778, as adopted in 1995.

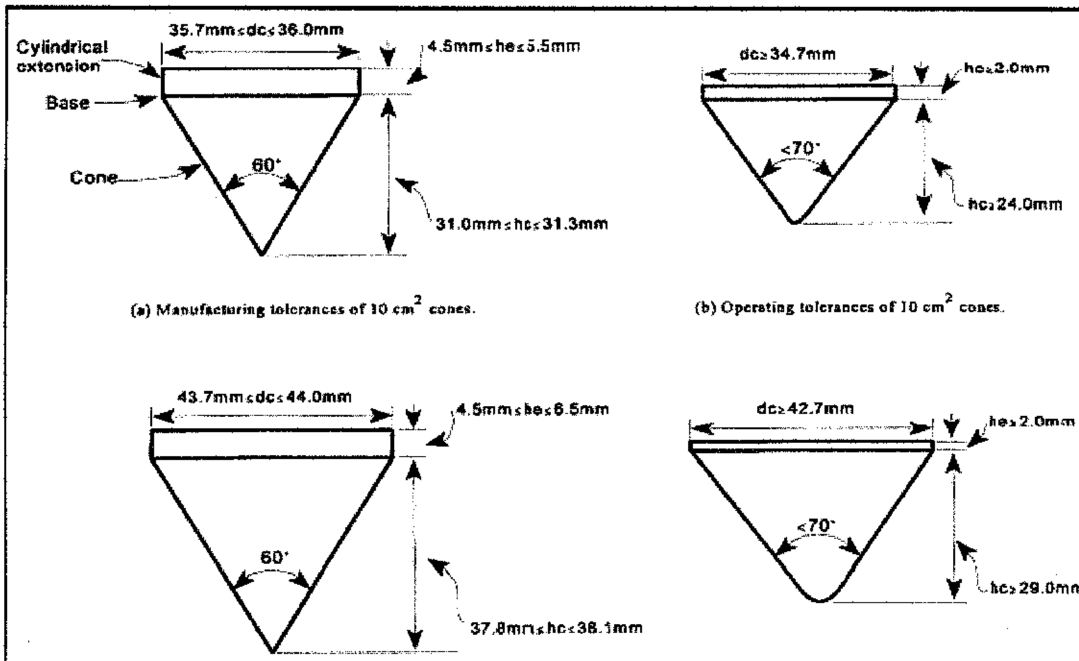
These devices produce a computerized log of tip and sleeve resistance, the ratio between the two, induced pore pressure just behind the cone tip, pore pressure ratio (change in pore pressure divided by measured pressure) and lithologic interpretation of each 2.5 cm interval are continuously logged and printed out.

2.1.2.1 Tip Resistance

Tip resistance is measured by the load cells located just behind the tapered cone (*Figure 2.1*). According to Robinson and Campanella (1986), it is in theory related to undrained shear strength of a saturated cohesive material, while the sleeve friction is theoretically related to the friction of the horizon being penetrated. The tapered cone head forces failure of the soil about 15 inches (381mm) ahead of the tip and the resistance is measured with an embedded load cell.

2.1.2.2 Local Friction

The local friction is measured by tension load cells embedded in the sleeve for a distance of 4 inches (101.6mm) behind the tip (*Figure 2.1*). They measure the average skin friction as the probe is advanced through the soil. If cohesive soils are partially saturated, they may exert appreciable skin friction, negating the interpretive program.



(a) Manufacturing tolerances of 10 cm^2 cones. (b) Operating tolerances of 10 cm^2 cones.

(c) Manufacturing tolerances of 15 cm^2 cones. (d) Operating tolerances of 15 cm^2 cones.

CONE BASE AREA	NOMINAL			TOLERANCE MANUFACTURED (OPERATIONS)		
	BASE DIAMETER	CONE HEIGHT	EXTENSION			
cm^2	dc mm	hc mm	he mm	dc mm	hc mm	he mm
10	35.7	31.0	5.0	+0.3 - 0.0 (≥34.7)	+0.3 - 0.0 (≥24.0)	+0.0 - 0.5 (≥2.0)
15	43.7	37.8	5.0 - 6.0	+0.3 - 0.0 (≥42.7)	+0.3 - 0.0 (≥29.0)	+0.0 - 0.5 (≥2.0)

Manufacturing and Operating Tolerances of Cones (2)

Figure 2.1: Schematic section through an electric friction-cone penetrometer tip ***(After ASTM D3441)***

2.1.2.3 Friction ratio

Friction ratio is specified in percentage. It is the ratio of skin friction divided by the tip resistance. The friction ratio is used to classify the soil either by its behavior, or reaction to the cone being forced through the soil. Clayey materials (high c, low Ø) generally indicate high ratios while lower ratios are typical of sandy materials (or dry desiccated clays). The values usually fall in the range of 1 % to 10%. However if it does fall out of the range, it seldom exceeds 15%. Sands are generally identified by exhibiting a ratio < 1%.

2.1.2.4 Pore Pressure

The instrument measures in-situ pore pressure, in either dynamic mode (while advancing the cone) or static mode (holding the cone stationary). Piezocones employ a porous plastic insert just behind the tapered head that is made of hydrophilic polypropylene, with a nominal particle size of 120 microns (*Figure 2.2*).

For precaution, the piezo-cell has to be saturated with glycerin prior to its employment. The filter permeability is about 0.01 cm/sec (1 x 10^{-2} cm/sec). When the test is to be carried out in dense layers, such as cemented siltstone, sandstone or conglomerate, the piezo filter element can become compressed, thereby inducing high positive pore pressures.

However, the plastic filters do not exhibit this tendency, though they do become brittle with time and may need to be replaced periodically. In stiff over-consolidated clays the pore pressure gradient around the cone may be quite high. This pore pressure gradient often results in dissipations recorded behind the CPT tip that initially increase before decreasing to the equilibrium value.

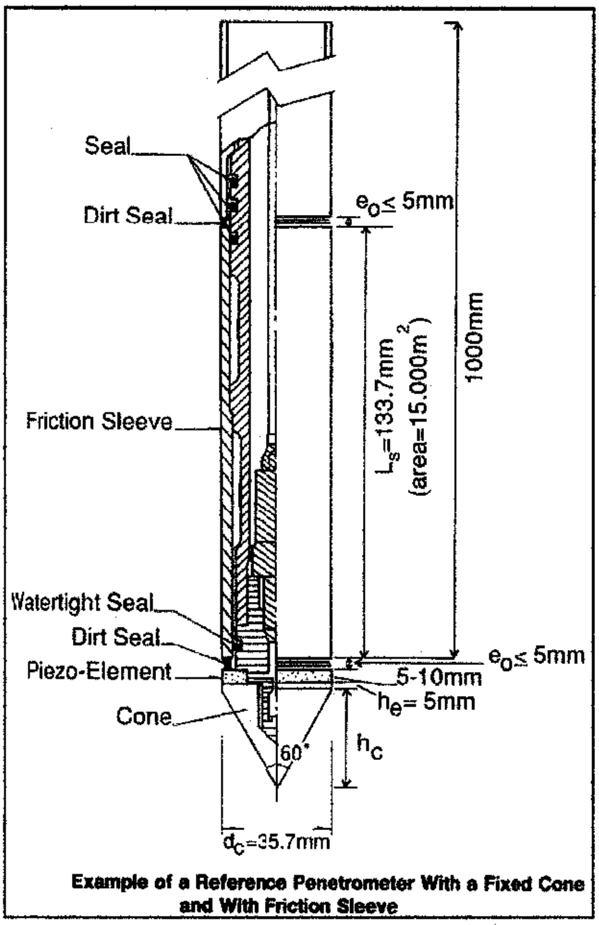


Figure 2.2: Schematic section through a piezocone head, showing the piezo-element and friction sleeve ***(After ASTM D5778).***

2.1.2.5 Differential Pore Pressure

Differential Pore Pressure Ratio is used to assist in soil classification according to the Unified Soil Classification System (USCS). As the cone penetrates dense materials such as sand, the sand dilates and the pore pressure drops. In clayey materials high pore pressures may be induced by the driving of the cone head. If transient pore pressures are being recorded that seem non-hydrostatic, most experienced operators will ask that the penetration be halted and allowed at least 5 minutes to reach its equilibrium state, so a quasi-static pore pressure reading can be recorded. Sometimes equilibration can take 10 to 30 minutes, depending on the soil. In practice experienced operators try to stop the advance and take pore pressure measurements in recognized aquifers and just above or adjacent to indicated aquacludes.

2.1.2.6 Temperature sensor

Temperature sensor is a great advantage of the electric cone. It has been found to be very practical in assessing the precise position of the zone, or zones, of saturation, which is of great importance in slope stability and consolidation studies. A temperature shift of about 6° F is common at the groundwater interface, even perched horizons within landslides.

2.1.2.7 Corrected Logs

Normally CPT rigs are well equipped with one or several automated interpretation programs, according to the Unified Soil Classification System. The most widely employed routine has been that originally developed by Robinson and Campanella (1986). The interpretation programs evaluate all of the measured properties and classify the horizon according to its behavior. For instance, when classifying a clayey material the interpretive programs consider undrained shear strength, tip resistance and differential pore pressure. A high differential pore pressure is assumed diagnostic of more clayey materials.

2.1.2.8 Notes of Caution

When the CPT method is applied for evaluating discrete low-strength horizons or partings, such as landslide slip surfaces, caution have to be taken. The 60° tip of the cone forces a passive failure of the ground in front of the advancing tip.

The instrument tip senses soil resistance about 21cm (8.4 in) ahead of the advancing tip. This means that the tip resistance reported as "undrained shear strength" is actually an average value, taken over the zone within 21 cm of the cone tip. If the tip penetrates low strength horizons less than 21 cm thick, such as a landslide slip surface, the tip resistance reported on the CPT log may be much higher than actually exists on the discrete plane of slippage, which maybe only a fraction of an inch thick.

Another problem with the CPT method is that cone soundings advanced through desiccated clay will often be interpreted as sand or silt mixtures (by the computerized lithologic interpretation routine) because of recorded sleeve friction.

2.1.2.9 CPT logs

The CPT Logs are representative of the features common to electronic friction cones. They include raw data sensed by the cone as it is pushed through the ground. This data includes: Friction Ratio, Local Friction, Tip Resistance, Pore Pressure, Differential Pore Pressure Ratio and an interpreted lithologic profile (often printed out on a separate sheet, depending on which interpretation program is being utilized)..

2.2 Slope Erosion Assessment

Several terms are used in association with the removal of soil from the land surface. Although there is no complete agreement in the connotations attributed to these terms, the following definitions are employed here. Erosion includes a group of processes by which earth materials are entrained and transported across a given surface.

During a storm, raindrop falls and absorbed into the pore spaces of the soil. When the infiltration rate is lower than the rain intensity, or when these pore spaces become saturated, the raindrops will flow down the slope. As the water flows, it will carry with it soil particles. This is the start of soil loss or erosion.

As the intensity of the rainfall increase, runoff increase, force increase and more material will be moved. At steeper slopes with lesser cover such as vegetation, the runoff flow faster and more force it will have to move material.

Rill erosion often occurs with sheet erosion and is commonly seen in paddocks of recently cultivated soils following high-intensity rainfall. It is easily identified as a series of little channels or rills up to 30 cm deep.

Figure 2.3: Typical Rill Erosion

Raindrops striking exposed soil detach the soil particles and splash them into the air and into shallow overland flows. Raindrops striking these shallow flows enhance the flow's turbulence and help to transport more of the detached sediment to a nearby rill or flow concentration.

Figure 2.4: Interill Erosion

Interill is thesoil loss from a hill slope caused by raindrop impact and overland flow. Interill detachment is affected by the cover provided by residues and plant canopy. Delivery of interill sediment to the rill channels is a function of the slope, cover, and surface roughness.

If rainfall exceeds infiltration, a surface film of water forms. Rill erosion results from a concentration of this surface water into deeper, faster-flowing channels which follow depressions or low points through paddocks. The shearing power of the water can detach, pick up and remove soil particles making these channels the preferred routes for sediment transport. Rill erosion is often described as the intermediate stage between sheet and gully erosion.

The loss of topsoil and nutrients reduces productivity greatly, as the remaining subsoils are often much less fertile. Also related soil deposition off-site causes sedimentation of streams, dams and reservoirs, resulting in water-quality deterioration and damage to aquatic habitats.

Slope erosion, is affected by three factors, namely the amount and rate of rainfall, and the steepness or gradient of the slope.

Heavy rain on a fairly even slope creates "sheet runoff." The water flows downslope as an even sheet. Any dips in the slope will collect more runoff water, which will be able to erode more strongly. If the force of this water is not stopped it will produce a gully. The gully will collect more and more water and cause even more erosion.

Soil loss is that material actually removed from the particular hill slope or hill slope segment. The soil loss may be less than erosion due to on-site deposition in micro-topographic depressions on the hill slope. The sediment yield from a surface is the sum of the soil losses minus deposition in macro-topographic depressions, at the toe of the hill slope, along field boundaries, or in terraces and channels sculpted into the hill slope.

Revised Universal Soil Loss Equation (RUSLE) estimates soil loss from a hill slope caused by raindrop impact and overland flow (collectively referred to as "interrill" erosion), plus rill erosion. It does not estimate gully or stream-channel erosion.

RUSLE is a computation method which may be used for site evaluation and planning purposes and to aid in the decision process of selecting erosion control measures. It provides an estimate of the severity of erosion. It will also provide numbers to substantiate the benefits of planned erosion control measures, such as the advantage of adding a diversion ditch or mulch.

CHAPTER 3 - METHODOLOGY

3.1 General

This approach involves 2 phases, namely "Diagnostics" and "Analysis". In the "Diagnostics " phase, the failure mode will be identified via rules and existing knowledge based on data collected, such as site investigation reports, while in the "Analysis" phase, the remedial options will be studied to determine the appropriate solution to the problem.

This approach, being dependent only on data analysis, required no bench-scale experiments to be conducted for identification of the problem. Furthermore, such an approach being algorithmic in nature, involve less expenditure in terms of monetary as no costly site or laboratory procedures is adopted. However, a site visit is considered to be necessary in order to get a grasp of the actual site condition.

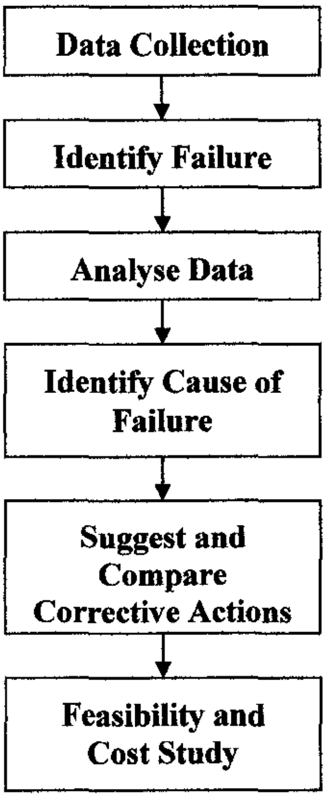


Figure 3.1 Methodology

3.2 Soil Stratigraphy Determination Method

The Piezocone is a very useful and valuable application in Stratigraphy and characterization. This in-situ test is most superior to any existing method because it provides a continuous profile of the soil and is relatively inexpensive. More test locations can be done providing a closer interval for visualization of the soil conditions. In this study, the Piezocone test results are used to supplement the limited number of boreholes.

Using raw data, characteristic soil description can be determined. Average Piezocone parameters at one standard deviation from selected layers are plotted on profiling charts.

Essentially for clays and silts, Piezocone is undrained thus measurement of Pore Pressure is important since the rate of Pore Pressure Dissipation is a key to classification. However, due to the uncertainty of the parameters, the more conservative charts being adopted in this study are *Figure 3.2 The Robertson & Campanella Soil Classification from Cone Penetrometer (1983)* and *Figure 3.3 The Schmertmann Profiling Chart (1978).*

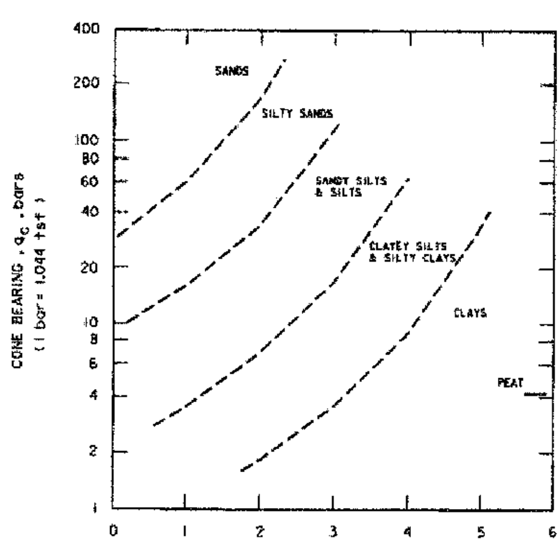


Figure 3.2 Soil Classifications from Cone Penetrometer ***(Robertson and Campanella 1983)***

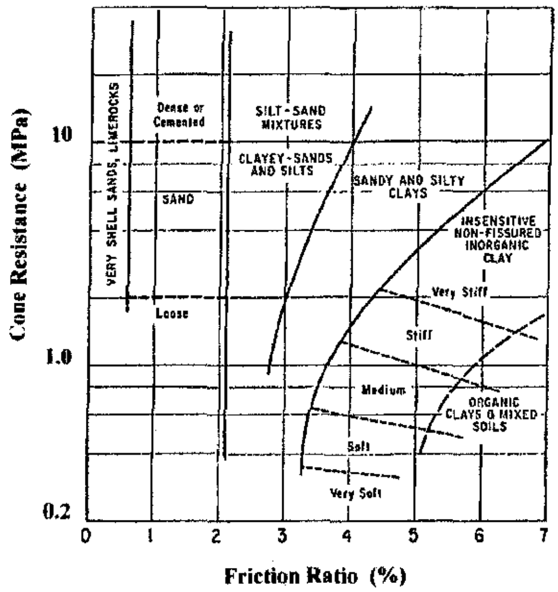


Figure 3.3 The Schmertmann Profiling Chart ***(Schmertmann, 1978)***

Robertson and Campanella (1983) suggested that profiling charts are still global in nature and other factors should be considered while using it as a guide to define soil behavior type. The factors that will influence the soil classifications are change in stress history, in situ stresses, density, stiffness, macrofabric, mineralogy and void ratio.

Due to constraint and limited resources, the factors mentioned cannot be justified. Therefore a comparison between the two mentioned charts is carried out to determine its suitability and accuracy for the project site.

According to Fellenius and Eslami (2000), most of the CPT methods are locally developed, that is, they are based on limited types of CPT soundings and soils, and therefore may not be relevant outside the local area. Therefore a simple analysis is hereby being done to determine which classification chart is most suitable for this particular site.

To provide a comparison, 2 series of data were compiled where the soil profiles had been established independently using boreholes. The two points are CP13 and CP14 where two rotary boreholes, BH 1 and BH 2 each of 20 meters depth were carried out close by (*Refer Appendix B*).

The results of the comparison are presented in *Table 3.1*. Both methods give almost the same degree of accuracy. *Schmertmann* provide an additional parameter on the stiffness of the material. However the results are not encouraging as is it not consistent with the Field Bore Log. Therefore, *Robertson & Campanella Chart (1983)* will be used through out this project.

Table 3.1 Robertson & Campanella (1983) vs. Schmertmann (1978) Soil Profiling Chart

Layer	Depth Below Ground Surface (m)	Thickness of Layer (m)	Field Bore Log	Robertson & Campenella (1983)	Schmertmann (1978)
CP-13 vs. BH1					
Layer 1	0.00	5.35	Sandy clayey SILT	Clays	Organic Clays
Layer 2	5.35	1.55	Loose, Coarse to fine silty SAND with a little fine gravel	Sands	Dense Sand
Layer 3	6.90	3.90	Loose, Coarse to fine silty SAND with a little fine gravel	Silty Clays	Silty Clay
Layer 4	10.80	0.75	Loose, Coarse to fine clayey silty SAND and fine gravel	Silty Sands	Medium Dense Sand
Layer 5	11.55 13.35	1.80	Loose, Coarse to fine clayey silty SAND and fine gravel	Clays	Medium Stiff Clay
CP-14 vs. BH2					
Layer 1	0.00	6.05	Sandy clayey SILT	Clays	Organic Clays
Layer 2	6.05	0.70	Medium dense, coarse to fine silty SAND with a little of fine gravel	Silty Sands	Medium Dense Sand
Layer 3	6.75	0.30	Medium dense, coarse to fine silty SAND with a little of fine gravel	Sand	Very Shell sands, Limerocks
Layer 4	7.05	1.60	Medium dense, coarse to fine silty SAND with a little of fine gravel	Silty Sands	Very Shell sands, Limerocks

Layer	Depth Below Ground Surface (m)	Thickness of Layer (m)	Field Bore Log	Robertson & Campenella (1983)	Schmertmann (1978)
CP-14 vs. BH2 (con't)					
Layer 5	8.65	0.65	Medium stiff, sandy clayey SILT	Sands	Very Shell sands, Limerocks
Layer 6	9.30	1.70	Stiff, sandy clayey SILT with traces of fine gravel	Sandy Silts	Clayey Sand & Silts
Layer 7	11.00	1.15	Medium stiff, sandy clayey SILT	Silty Sands	Medium Dense Sand
Layer 8	12.15 13.50	1.35	Stiff, sandy clayey SILT with traces of fine gravel	Silts	Sandy & Silty Clays

We know that the CPT procedure is often capable of detecting discrete horizons that would normally be missed using drive samples at specific depth intervals. According to Fellenius and Eslami (2000), the CPTu is an excellent tool for the geotechnical engineer in developing a site profile. Naturally, it cannot serve as the exclusive site investigation tool and soil sampling is still required. However, when the CPTu is used to govern the depths from where to recover soil samples for detailed laboratory study, fewer sample levels are needed, reducing the costs of a site investigation while simultaneously increasing the quality of the information because important layer information and layer boundaries are not overlooked.

In 1965, the pioneer *Begemann*, had made the first attempt to produce soil profil from the CPT, showing that, while coarse-grained soils generally demonstrate larger values of cone resistance, and sleeve friction, than do fine-grained soils, the soil type is not a strict function of either cone resistance or sleeve friction, but of the combination of the these values.

By using the *Robertson & Campanella Chart (1983),* CPT data for Row 1 and Row 2 as shown in attachment are classified and a profile of the long section is plotted (Figure 3.4). This method will be refined and used to produce long sections, as well as cross sections for the remaining CPT data for further assessment.

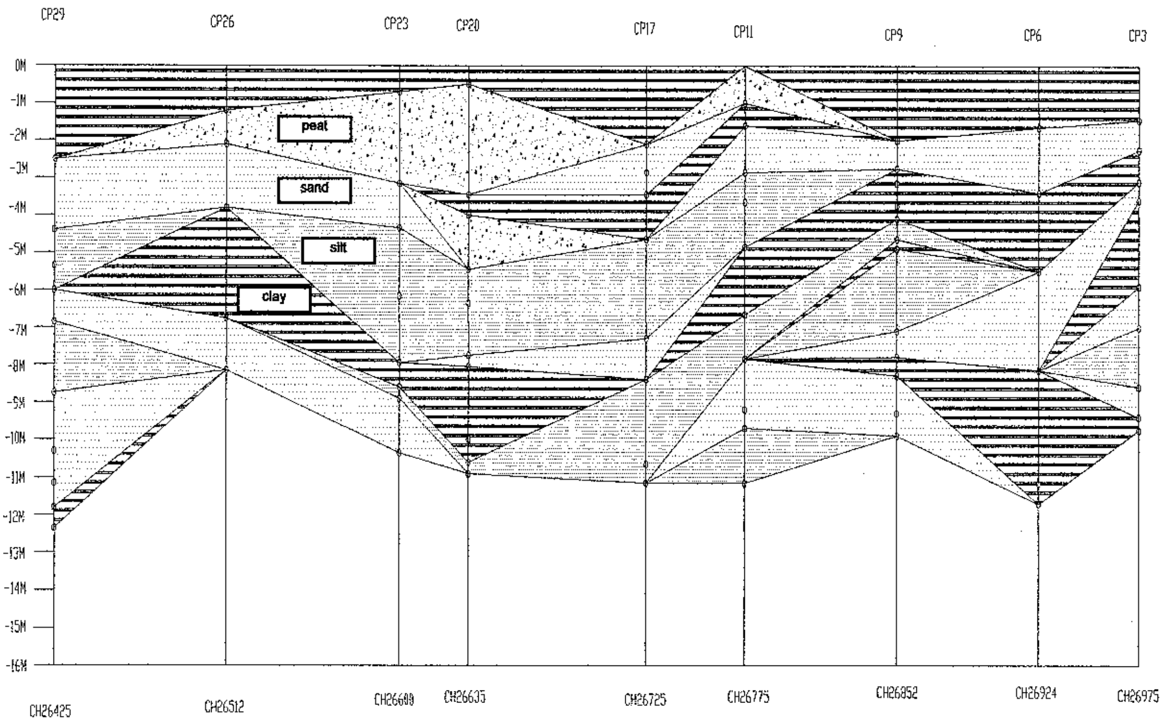


Figure 3.4: Typical Soil Profile

Schneider, Peuchen, Mayne & McGillivray (2001) concluded that classification based on the *Robertson et al. (1986)* soil behavior type charts shows some minor discrepancies when compared to visual classification. From their work, it can be seen that it is inferred from the relatively high friction ratio values that the soils contain a significant amount of fine grained particles, but soils are visually classified as sandy materials.

Despite the fact that it is difficult to assess whether a soil is sandy silt or silty sand, classification based on the charts tends to predict that the soils have a more clayey behavior than is assessed from essentially drained construction induced loading. High lateral stresses locked into the residual soil structure may be leading to a greater increase in friction ratio than that which is typically associated with over consolidation.

3.3 Slope Assessment

The Revised Universal Soil Loss Equation (RUSLE) is a set of mathematical equations that estimate average annual soil loss and sediment yield. It is derived from the theory of erosion processes, more than 10,000 plot-years of data from natural rainfall plots and numerous rainfall-simulation plots. It retains the structure of its predecessor, the Universal Soil Loss Equation (USLE).

The science of predicting soil erosion and sediment delivery has continued to be refined to reflect the importance of different factors on soil erosion and runoff. The Revised Universal Soil Loss Equation (RUSLE) has improved the effects of soil roughness and the effects of local weather on the prediction of soil loss and sediment delivery.

This method is used to estimate the severity of soil loss and sediment yield from disturbed-land surfaces and to select appropriate on-site erosion-control strategies. These strategies are designed to protect soil resources so that their quality and quantity are maintained over the long- term, to provide short-term erosion control while the long-term erosion-control measures become established. A well planned and engineered erosion control and/or water management plan will alleviate many concerns about construction site erosion.

The basic principles governing soil losses due to raindrop impact, overland flow, and rill-erosion processes (removal of soil by concentrated water running through little streamlets) remain the same for all land uses where the soil or surface material is exposed.

The RUSLE equation is as follows:

$$\mathbf{A = RK(LS)C\ P} \qquad \textbf{(3.1)}$$

Where:

A = Average annual soil loss in tons per acre per year

R = Rainfall factor

K = Soil erodibility

LS = topographic index (length slope)

C = Cover-management

P = Support practice

The rainfall factor (R) in Eq. 3.1 is an expression of the erosivity of rainfall and runoff at a particular location. Its value of R increases as the amount and intensity of rainfall increase. Analyses of data indicated that when factors other than rainfall are held constant, soil loss is directly proportional to a rainfall factor composed of total storm kinetic energy (E) times the maximum 30-min intensity (I_{30}) *(Wischmeier and Smith, 1958*). The desired numerical value of R is the average annual sum of EI_{30} for storm events during a rainfall record of at least 22 years. Erosion Index represents the energy and intensity. The energy component is related to the size of the raindrops while the intensity is the maximum intensity measured in inches per hour. Erosion Index is frequently illustrated in graphs by showing the percent of occurrences within a period of days or months. From the index, one can determine the period when the most intense storms are likely to occur. In some circumstances where only Annual Precipitation (Pa) totals are available to make estimates of the R factor, RUSLE users are referred to *Renard and Freimund (1994).* The procedure provided is only used as a last resort when there is no other alternative. For Pa > 850mm, *Renard and Freimund* suggested the following equation derived based on data from 155 stations in the United States.

$$\mathbf{R = 587.8 - 1.249Pa + 0.004105Pa^2} \qquad \mathbf{(3.2)}$$

Referring to Eq. 3.1, K is the soil erodibility factor. The value for the subsoil condition, usually encountered in construction sites, can be determined based on soil texture (relative percent of sand, silt, and clay). However, K values for subsoils are not always available. Approximated K values for some representative soils on construction sites can be used based on previous similar case. K value can be obtained from table below.

Table 3.2 Approximate values of factor K for USDA textual classification

Texture Class	Organic Material Content		
	<0.5% K	2% K	4% K
Sand	0.05	0.03	0.02
Fine sand	0.16	0.14	0.10
Very fine sand	0.42	0.36	0.28
Loamy sand	0.12	0.10	0.08
Loamy fine sand	0.24	0.20	0.16
Loamy very fine sand	0.44	0.38	0.30
Sandy loam	0.27	0.24	0.19
Fine sandy loam	0.35	0.30	0.24
Very fine sandy loam	0.47	0.41	0.33
Loam	0.38	0.34	0.29
Silt loam	0.48	0.42	0.33
Silt	0.60	0.52	0.42
Sandy clay loam	0.27	0.25	0.21
Clay loam	0.28	0.25	0.21
Silty clay loam	0.37	0.32	0.26
Sandy clay	0.14	0.13	0.12
Silty clay	0.25	0.23	0.19
Clay		0.13-0.29	

Source: Table 12.9, Oweis & Khera, 1998

The effect of topography on erosion is accounted for by the LS factor Eq. 3.1. It combines the effects of a hill slope-length factor, L, and a hill slope-gradient factor, S. L is the horizontal length of slope measured in feet It is the point of origin where water will begin flowing down the slope to the point where concentrated flow begins, such as where water flows into a ditch, or deposition occurs and water disperses. It is measured and calculated from the As Built Drawings. S is the slope gradient and represents the effect of slope steepness on erosion. Slopes may be uniform, concave (flattening toward the lower end) or convex (steepening toward the lower end). If the slope is concave, the LS factor will be slightly lower. If convex, then the LS will be slightly higher. Generally, as hillslope length and/or hillslope gradient increase, soil loss increases. As hillslope length increases, total soil loss and soil loss per unit area increase due to the progressive accumulation of runoff in the downslope direction. These factors are interrelated and the LS factor can be obtained from the following table.

Table 3.3 LS values for freshly prepared constructed and other highly disturbed soil condition with little or no cover. *(Source*: Institute of Water Research, Michigan State University, 2002.)

Slope (%)	Slope Length (ft.)																
	<3	6	9	12	15	25	50	75	100	150	200	250	300	400	600	800	1000
0.2	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.06
0.5	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.09	0.09	0.1	0.1	0.1	0.11	0.12	0.12	0.13
1	0.09	0.09	0.09	0.09	0.09	0.1	0.13	0.14	0.15	0.17	0.18	0.19	0.2	0.22	0.24	0.26	0.27
2	0.13	0.13	0.13	0.13	0.13	0.16	0.21	0.25	0.28	0.33	0.37	0.4	0.43	0.48	0.56	0.63	0.69
3	0.17	0.17	0.17	0.17	0.17	0.21	0.3	0.36	0.41	0.5	0.57	0.64	0.69	0.8	0.96	1.1	1.23
4	0.2	0.2	0.2	0.2	0.2	0.26	0.38	0.47	0.55	0.68	0.79	0.89	0.98	1.14	1.42	1.65	1.86
5	0.23	0.23	0.23	0.23	0.23	0.31	0.46	0.58	0.68	0.86	1.02	1.16	1.28	1.51	1.91	2.25	2.55
6	0.26	0.26	0.26	0.26	0.26	0.36	0.54	0.69	0.82	1.05	1.25	1.43	1.6	1.9	2.43	2.89	3.3
8	0.32	0.32	0.32	0.32	0.32	0.45	0.7	0.91	1.1	1.43	1.72	1.99	2.24	2.7	3.52	4.24	4.91
10	0.35	0.37	0.38	0.39	0.4	0.57	0.91	1.2	1.46	1.92	2.34	2.72	3.09	3.75	4.95	6.03	7.02
12	0.36	0.41	0.45	0.47	0.49	0.71	1.15	1.54	1.88	2.51	3.07	3.6	4.09	5.01	6.67	8.17	9.57
14	0.38	0.45	0.51	0.55	0.58	0.85	1.4	1.87	2.31	3.09	3.81	4.48	5.11	6.3	8.45	10.4	12.23
16	0.39	0.49	0.56	0.62	0.67	0.98	1.64	2.21	2.73	3.68	4.56	5.37	6.15	7.6	10.26	12.69	14.96
20	0.41	0.56	0.67	0.76	0.84	1.24	2.1	2.86	3.57	4.85	6.04	7.16	8.23	10.24	13.94	17.35	20.57
25	0.45	0.64	0.8	0.93	1.04	1.56	2.67	3.67	4.59	6.3	7.88	9.38	10.81	13.53	18.57	23.24	27.66
30	0.48	0.72	0.91	1.08	1.24	1.86	3.22	4.44	5.58	7.7	9.67	11.55	13.35	16.77	23.14	29.07	34.71
40	0.53	0.85	1.13	1.37	1.59	2.41	4.24	5.89	7.44	10.35	13.07	15.67	18.17	22.95	31.89	40.29	48.29
50	0.58	0.97	1.31	1.62	1.91	2.91	5.16	7.2	9.13	12.75	16.16	19.42	22.57	28.6	39.95	50.63	60.84
60	0.63	1.07	1.47	1.84	2.19	3.36	5.97	8.37	10.63	14.89	18.92	22.78	26.51	33.67	47.18	59.93	72.15

Again referring back to *Eq. 3.1*, C is the factor to reflect the planned cover over the soil surface. The C factor accounts for the influence of soil and cover management on erosion. Different cover types have different C factors, and impervious cover has a C factor of 1 because no water can penetrate through it. *Table 3.4* shows the values of typical C factor. For this study, a typical value of 0.01 is being used for permanent seedings after 12 months.

P in *Eq. 3.1* is the factor that represents management operations and support practices on a construction site. The P factor reflects the impact of support practices and the average annual erosion rate. In this study the P factor was set at 1 and assumed to be constant due to the very small size of the study area.

Table 3.4 Typical C factor values
(*Source*: Oweis & Khera, 1998)

Condition	C factor
Bare soil condition	
Freshly disked, 6-8 in.	1.00
After one rain	0.89
Loose, 12 in. thick	
Smooth	0.90
Rough	0.80
Compacted bulldozer scraped up and down	1.30
Same except roots raked	1.20
Compacted bulldozer scraped across slope	1.20
Rough irregular tracked in all directions	0.90
Seed and fertilize fresh	0.90
same after 6 months	0.54
Compacted fill	1.24-1.71
Saw dust, 2 in. deep dicked in	0.61
Dust binder	
605 gal/acre	1.05
1210 gal/acre	0.29-0.78
Hydromulch (wood fiber slurry), fresh	
1000 lb/acre	0.05
1400 lb/acre	0.01-0.02
Seedings	
Temparary, 0-60 days	0.40
After 60 days	0.05
Permanent, 0-60 days	0.40
2-12 months	0.05
After 12 months	0.01
Excelsior blanket w ith plastic net	0.04-0.10

CHAPTER 4 - RESULTS AND DISCUSSION

4.1 Site Observation

Various visual inspections and reconnaissances at the project site were conducted to gather information. The information assembled was obtained and used to facilitate the study of this Final Year Project.

Drawing No. AC/8898047/28/GIMP/009-ST provided in Appendix A shows that initially unsuitable material of about 2 to 2.5 meters thick are to be removed and replaced with suitable fill or granular material prior to the construction of the embankment.

The constructed embankment was covered with poorly grown hydro seeding. It is noticed that the slope surface are seriously eroded and gullies and holes of various depths and extent were formed. *See photoC1 and C2.*

Simultaneously the separation of Ballast/Subballast occurs, resulting in widely noticed scars as shown in *Photo C3.*

On the west side of the embankment between CH 26+675 to CH 26+325 concrete drain is completely silted to the extent that some vegetation have grown into it as shown in *Photo C4*. Cracks were also noticeable along the drain.

4.2 Failures Encountered

The failure encountered in this site can be categorized into the followings:

i. General erosion of the slope resulting in scars and gullies

ii. Erosion of the toe of the embankment

iii. Excessive settlement of the formation.

4.3 Assessment of Cause of Failure

Initial assessment suggests that these failure were due to improper drainage, improper slope protection, probable weak fill material within the embankment slope, improper compaction of the replaced material and improper compaction of the side slopes of the embankment.

4.3.1 Piezocone Penetration Test

A total of thirty three numbers of Piezocone Penetration Test were carried out to assess the failure as shown in *Appendix D*. The tests were carried out at the toe of the embankment, on the slope, and at the ballast formation. One piezocone each was taken close to BH 1 and BH 2. The tip and friction resistances, friction ratio, pore water pressure and pore pressure ratio are measured at intervals of 50mm vertically.

Row 1 and Row 5 (*Appendix D*) are located at the toe of the embankment. The Tip Resistance vs. Depth plot reveals that approximately the top 5 meters of the material are low in shear strength and high in compressibility. Conclusion can be made that the 2.5 meters ground improvement work (replacement and compaction) was not appropriately conducted as required.

Row 2, Row 3 and Row 4 sit on the slope of the embankment and the ballast formation, suggested that the layer of material are comparatively higher in shear strength and lower in compressibility. Yet, when we look at CP-21, CP-24 and CP-27 in Row 1, as well as CP-2, CP-5, CP-8, CP-13, CP-16 and CP-22 in Row 3, it does not show a consistent pattern which may suggest that there are no proper compaction control during the construction phase.

We suspect that the use of non granular material may contribute to the above. Interpretation of the soil profile had been carried out and the cross section and long section profiles are attached in *Appendix E.*

The profile suggested that the materials used are mostly clay in nature. It shows that the Remove and Replace procedure was done with cohesive material rather than granular material.

4.4 Assessment of Slope

Erosion-control measures have become standard operating procedures on many mined lands and construction sites resulting in long-term stabilized areas, reduced sediment basin clean-out costs, and reduced potential off-site impacts. Consideration of selection can whether be leaving the soil surface in a roughened state, using mulch or a temporary cover crop, contouring, and terracing, or establishing sustainable vegetation. With RUSLE the benefits of these and other erosion-control measures can be estimated and alternative reclamation plans can be readily compared.

The RUSLE is applied to estimate the soil loss rate for this study site and the results are summarized in *Table 4.1*.

The C factor is obtained from *Table 3.4*. Permanent seedings after 12 months bear a typical value of 0.01 for the site. The P factor was set at 1 and assumed to be constant due to the very small size of the of the study area. R was computed based on the *Eq. 3.2* with an Annual Precipitation of 2694.5mm computed from raw data. Conversely, K value is obtained from *Table 3.2*. *Table 3.3* is ultilised to acquire the LS factor corresponding to the typical 1:2 slope gradient and respective slope length at each cross section.

Table 4.1 Computation of soil loss in tons per acre per year

Cross Section	Chainage	C	P	R	K	East				West			
						Height of Slope (m)	Length of Slope (in.)	LS	A=RKLSCP (tonne/acre/year)	Height of Slope (m)	Length of Slope (in.)	LS	A=RKLSCP (tonne/acre/year)
1	26340	0.01	1	27026.03	0.05	5.169	455	0.12	1.622	4.503	396	0.11	1.486
2	26425	0.01	1	27026.03	0.05	5.424	477	0.12	1.622	4.291	378	0.11	1.486
3	26512	0.01	1	27026.03	0.05	4.343	382	0.11	1.486	3.756	331	0.11	1.486
4	26600	0.01	1	27026.03	0.05	2.758	243	0.10	1.351	4.209	371	0.11	1.486
5	26635	0.01	1	27026.03	0.05	3.467	305	0.11	1.486	3.896	343	0.11	1.486
6	26725	0.01	1	27026.03	0.05	3.619	319	0.11	1.486	3.392	299	0.10	1.351
7	26850	0.01	1	27026.03	0.05	2.333	205	0.10	1.351	2.798	246	0.10	1.351
8	26925	0.01	1	27026.03	0.05	2.955	260	0.10	1.351	2.079	183	0.10	1.351
9	26975	0.01	1	27026.03	0.05	1.338	118	0.09	1.216	2.136	188	0.10	1.351
								Total	12.972			Total	12.837

Soil erosion risk was modeled within CH 26+340 and CH 26+975 of Kuantan Kerteh Railway Project, integrating the Revised Universal Soil Loss Equation (RUSLE). The quantitative data of predicted soil loss in each parameters (LS, R, K, C) was utilized to quantify data to identify areas that are the most susceptible to soil erosion within the study area.

Almost bare soils with clay contents ranging from moderate to high were estimated to have very high erosion. They showed higher values in slope-length. Some areas of lower elevation showed lower erosion risk. This is because bare soil induces high erosivity values, and high indices of erodibility.

Approaching the bridge abutment of Rail Over Sg. Air Jernih, the east side of the embankment between CH 26+340 to CH 26+425 (Cross Section 1 to 2) was considered to be at high risk with estimated soil loss of 1.622 tonne/acre/year. These sections recorded the highest embankment height of 5.4m within the study area with poor cover at the toe as shown in *Photo C-6.*

Conversely, the west side of the embankment of the same chainages with lower embankment height documented a lower estimation of soil loss, sum up to 1.486 tonne/acre/year. This is further verified by observing *Photo C-7*, it clearly shows that the erosion were minor to compare the east side.

On the other hand, slopes between CH 26+512 and CH 26+925 are exposed to moderate risk of erosion.

East slope at CH 26+975 in contrast, as shown in *Photo C-8* marked the least estimation of soil loss amounting to 1.216 tonne/acre/year. The height of the embankment at this stretch is the lowest of all.

Generally, based on the computation, total soil loss on the east side is 12.972 tonne/acre/year compare to 12.837 tonne/acre/year on the west. We can say that the erosion on the east side of the embankment is more severe and often occurs at localized spots explicitly at CH 26+340 to CH 26+425 and CH 26635 to 26+725.

Then again, the west side of the embankment endures consistent erosion alongside CH 26+340 to CH 26635 of the alignment. This can be clearly witnessed in *Photo C-9* to *Photo C-15*. Based on the visual surface mapping, we can conclude that the actual erosion demonstrated on the west side is actually more severe than the east side.

To explain the discrepancy on the above, the RUSLE is being observed. Consequently, based on the equation, we can conclude that as embankment height increases, length of slope increases, soil loss increases. Total soil loss and soil loss per unit area increase due to the progressive accumulation of runoff in the downslope direction.

Supplementary to the embankment height, the RUSLE does not consider the itinerary of the raindrops during a storm that is believed to contribute to the different degree of erosion. Extent of the erosion is severe when the rain hits the slope on an upright angle as illustrated in *Figure 4.1*. On the contrary, the slope plane which is parallel to the rain itinerary does not suffer as much.

Assuming that the raindrops actually hits the west side of the slope on an upright angle, would explain why the west side experienced more severe damage. In our opinion, this may be considered a shortcoming of the RUSLE equation which explained why the computed soil loss does not match the actual surface mapping.

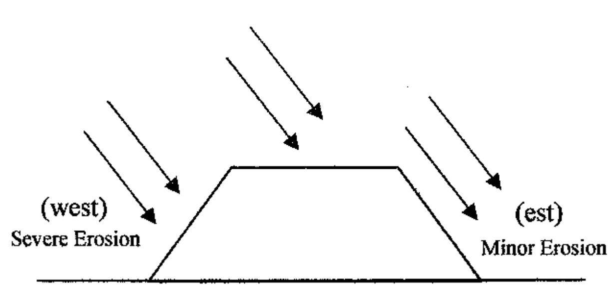


Figure 4.1 Itinerary of raindrops during a storm

4.5 Comparison of Remedial Alternatives

Two separate remedial actions were presented to the client to address the failure encountered in the stretch at hand of the KKRP railway. These two are labeled as Cosmic Accord Proposal and OGP Proposal respectively. The ultimate intention is to avoid further failure in the embankment that might affect the railway, to prevent further instability in the existing slopes, to improve drainage condition, and to avoid interruptions of track usage during reconstruction. Both are discussed in this sub chapter.

4.5.1 Option A - Cosmic Accord

Figure 4.2 presents rectification works for the slope and toe erosions as proposed and detailed.

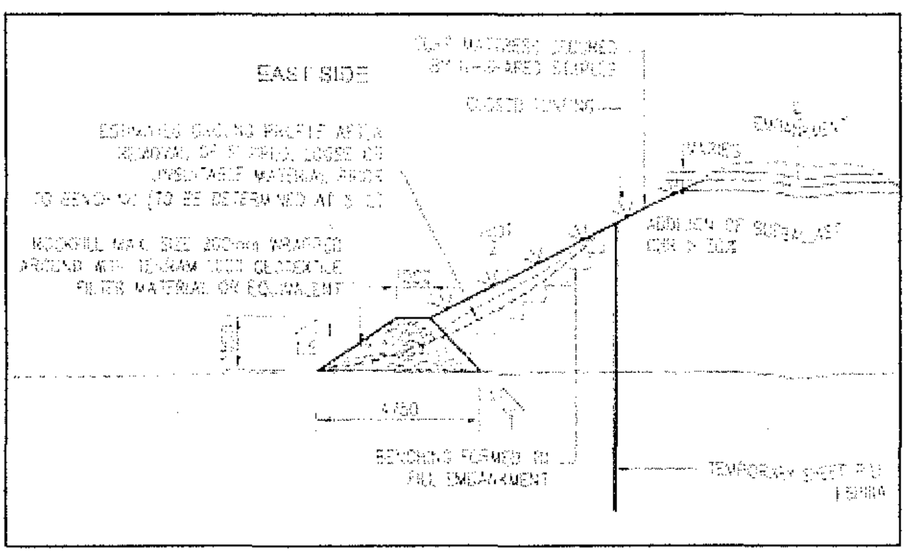


Figure 4.2 Option A – Cosmic Accord

In order to reconstruct and re-grade the slopes, the following construction sequence was suggested.

i. On any cross section, the rectification works should commence on one side of the embankment on only.

ii. Install temporary sheetpile wall.

iii. Remove the slipped loose or soft unsuitable material.

iv. Start benching based on ground profile after removal of slipped loose or soft unsuitable material

v. To check he base of rockfill prior to placement of rockfill

vi. Placement of rockfill toe wrapped around by geotextile.

vii. Progressive suitable fill layers to be laid with proper compaction

viii. Trimming of slope and installation of turf mattress upto the sheet pile level

ix. Install close turfing

x. Removal of sheet pile prior to constructing sheetpile on the opposite side of embankment

xi. To fill any gap with sand after removal of sheetpile.

Proper drainage measures, for both surface and subsurface, are essential. The fluctuation of water level between the lowest and the highest levels using backfill of fine grains will induce the build up of an excess pore water pressure, and this decrease the factor of safety against slip failure in the future. Therefore rockfill toe surrounded by filter geotextile was proposed to drain any excess pore water pressure. In addition, providing rock toe will reduce the length of rain travel along the slope over backfilled soil thus reducing the erosion. Furthermore, it acts as a berm for an embankment height of over 5 meters.

4.5.2 Option B - OGP

Figure 4.3 presents a cross section of the OGP Proposal. The following construction sequence was suggested.

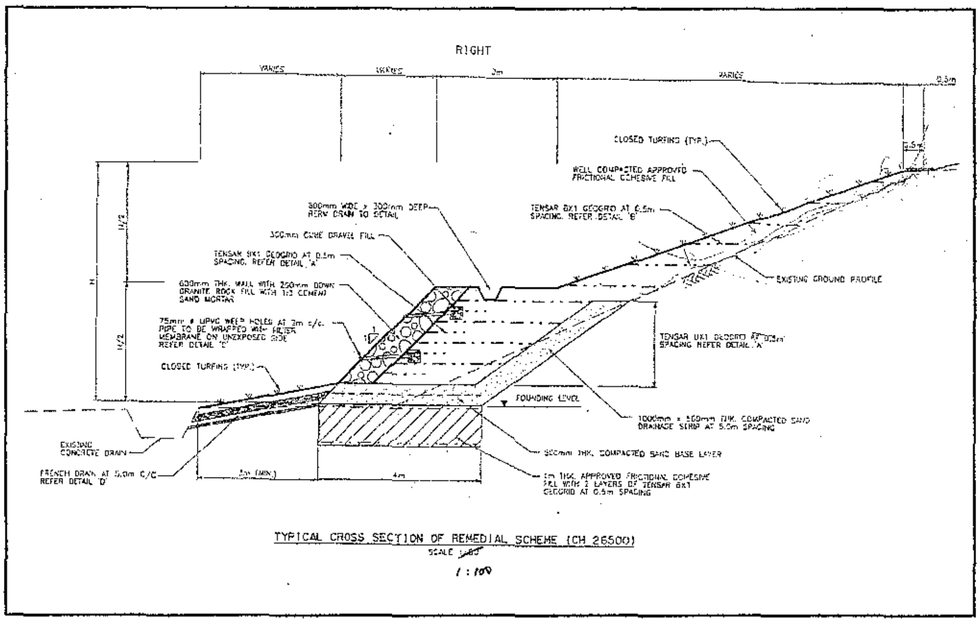


Figure 4.3 Option B – OGP

i. Remove the slipped loose or soft unsuitable material.

ii. Placement of approved frictional cohesive fill with Geogrid as base

iii. Construction of retaining structure as shown in figure, complete with weep holes and sand base as drainage layer.

iv. Progressive backfilling with suitable material with layers of geogrid for reinforcement with proper compaction.

v. Construction of French drain connecting sand base layer to existing concrete drain

vi. Construction of drainage and sump to joint up with the existing drain.

vii. Installation of close turfing.

As shown in *Figure 4.3*, retaining structure will be put up to strengthen the embankment. The usage of the Geogrid is intended to further reinforce the embankment. Drainage strip and French drain are part of the configuration to dissipate the pore water pressure in the embankment to prevent failure after construction.

4.5.3 Comparison between Option A and Option B

Assuming both methods are as effective. The methodology in Option B is far more complicated in terms of the construction wise with anticipated longer construction period. Specialist contractor are required for the specialized work of Geogrid application. Looking at the number of items involved in the system, there is a possibility of it having higher maintenance cost in the future is high.

Observing the application of the Geogrid on the narrow backfilling portion on the upper slope of the embankment; it is not feasible as the area is limited for the extensive usage of Geogrid which required a good compaction after backfilling. The materials involved in method B are more expensive; it involved a great deal of Geogrid.

In contrast, Option A suggested by Cosmic Accord would be described as more down to earth as it does not required complicated construction technique. It is easier to construct, in other words lower construction cost, which is most desirable in the construction industry.

A comparison of the above methods based on quantity wise was done as computed in *Table 4.2 and 4.3*. By just looking at the similar materials in both options, it can be concluded that the quantity of materials required in Option B is much higher than Option A. This will incur an additional cost on material if Option B is to be preferred over Option A.

By assembling the above rationale, Option A would be strongly recommended for the remedial work of the Kuantan Kerteh Railway Project.

Table 4.2 Bill Of Quantities for Option A – Cosmic Accord

Item	Description	Unit	Quantity
	Toe Drain		926
1.01	Rockfill maximum size 200mm	m3	3,826
1.02	Wrapped around with terram 100 geotextile filter material or equivalent	m2	12,585
1.03	Backfilling with suitable material	m3	4,769
1.04	Turf mattress secured by U-shaped staples	m2	5,556
1.05	Closed turfing	m2	5,556
1.06	Sealing of gap with sand	m3	556

Table 4.3 Bill Of Quantities for Option B– OGP

Item	Description	Unit	Quantity
	1m thick approved frictional cohesive fill wih 2 layers of tensar BX1 geogrid at 0.5m spacing.		
1.01	Cohesive fill	m3	3,704
1.02	Tensar BX1 Geogrid	m2	7,408
1.03	500m thick compacted sand base layer	m2	3,704
1.04	1000m x 500mm thick compacted sand drainage strip at 0.5 m spacing	m3	309
1.05	600mm thick wall with 200m down granite rock fill with 1:3 cement sand mortar.	m	926
1.06	300mm cube gravel fill with 75mm dia. UPVC weep holes at 2m c/c pipe to be wrapped with filter membrane on unexposed side	nos	932
1.07	Tensar BX1 geogrid at 0.5m spacing	m2	9,158
1.08	Tensar UX1 geogrid at 0.5m spacing	m2	11,931
1.09	Well compacted approved frictional cohesive fill	m3	6,172
1.10	Closed turfing	m2	8,334
	French Drain		
1.11	20mm single size aggregate wrapped with geotextile with 100mm dia. Perforated pipe wrapped with geotextile	m	564
1.12	600mm wide x 300mm deep Berm Drain	m	926
1.13	Cascade Drain	m	54
1.14	0.9m X 0.9m Sump	nos	9
1.15	200mm Mortar Slope apron underlaid with filter membrane	m2	6

CHAPTER 5 - CONCLUSION

The Kuantan-Kerteh Railway Project (KKRP) is a 72 km single track railway system owned by PETRONAS. It provides a container shuttle service for refinery products in the fast-growing Eastern Corridor petrochemical hub. Upon completion, several failures, including slope stability, erosion and settlement have been noticed along several stretches of the project. Consequently, the track is under-utilized and the speed of the train had to be lowered well below the design speed. An investigation was initiated by the owner to study this problem and to put forward counteractive actions.

In this report, literature reviews were done on the Piezocone Penetration Test and Slope Erosion Assessment (RUSLE) to form a basis for the study. Data were collected from time to time from various sources to facilitate the analysis. Furthermore, appropriate methodologies were chosen though a series of studies that best suit the site environment. Subsequently the project site condition was assessed and failures were identified.

The failures encountered were categorized accordingly and assessment suggested that such failures were due to improper practice in the process of constructing the embankment.

The effect of rainfall on the slope erosion is considered with relevant rainfall data. RUSLE estimation pronounces that the erosion on the east side of the embankment is more severe and often occurs at localized spots. In contrast, the visual surface mapping shows the otherwise. The discrepancy took place as the RUSLE does not consider the itinerary of the raindrops during a storm that is believed to contribute to the different degree of erosion. This shortcoming of RUSLE needs to be overcome before it can be fully ultilised as the rain itinerary as well affects the slope performance.

Last but not least, suggested corrective actions were compared in terms of feasibility. Two separate remedial actions, termed here as Option A and Option B were presented to the client to address the failure encountered in the stretch at hand of the KKRP railway. Comparison of the alternatives was done based on the complexity of construction technique and materials. Option A employed a simpler methodology with conventional materials which required shorter construction time frame and lower maintenance cost in the long run. In contrast, Option B required a more complex methodology with advanced construction material incurring higher cost. Option A in all aspects clearly overruled option B. Consequently, Option A would be strongly recommended for the remedial work of the Kuantan Kerteh Railway Project.

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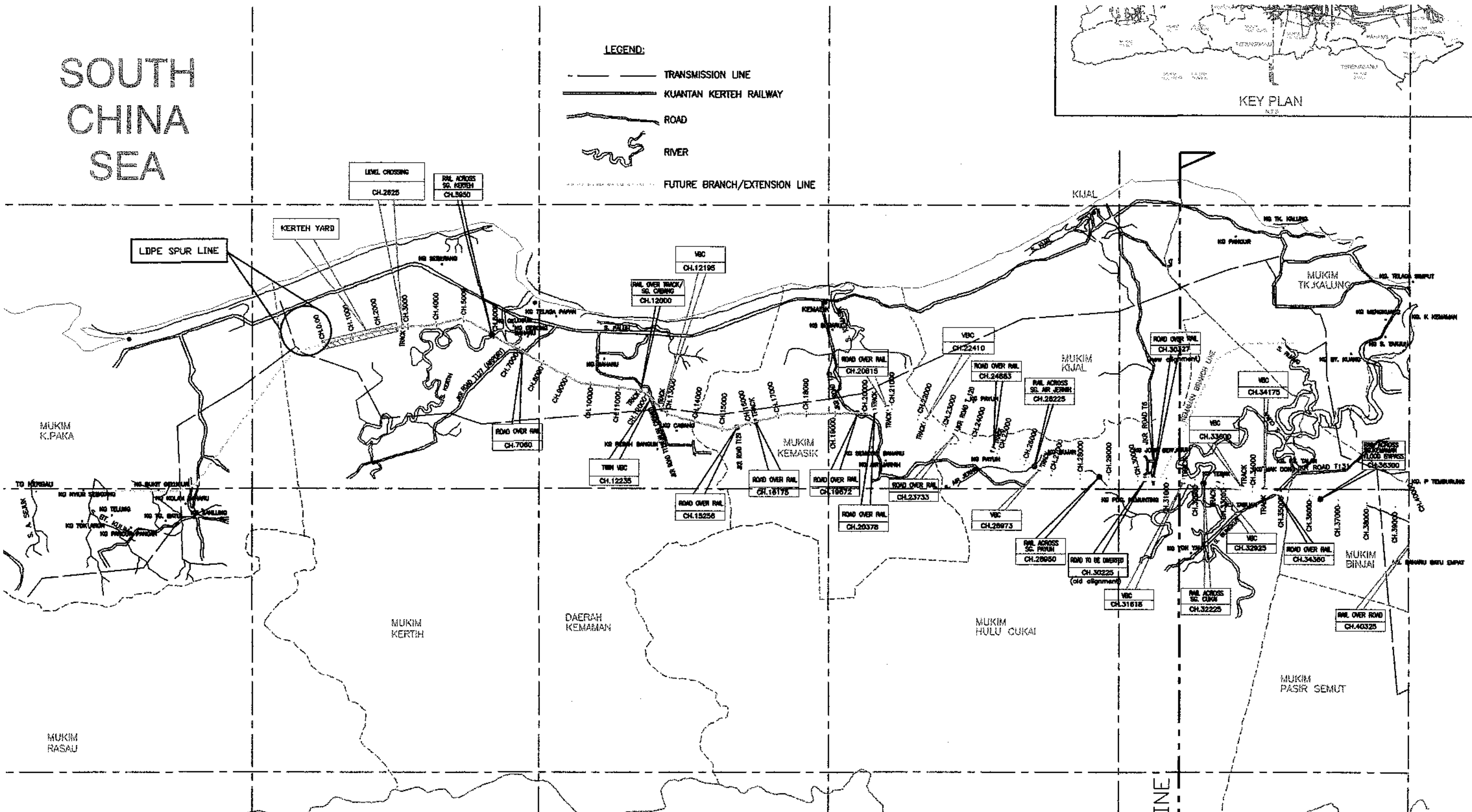
Wischmeier, W.H. and D.D. Smith, 1958. *Rainfall Energy And Its Relationship To Soil Loss*. Am. Geophy. Union, Trans. 39(2): 285-291.

Appendix A

Project Drawings



PETRONAS REGISTERED LICENSED SURVEYOR

JURUKUR TEGUH

MINCONSULT SDN. BHD.

KUANTAN - KERTEH RAILWAY PROJECT

KEY PLAN AND LOCATION PLAN (SHEET 1 OF 2)

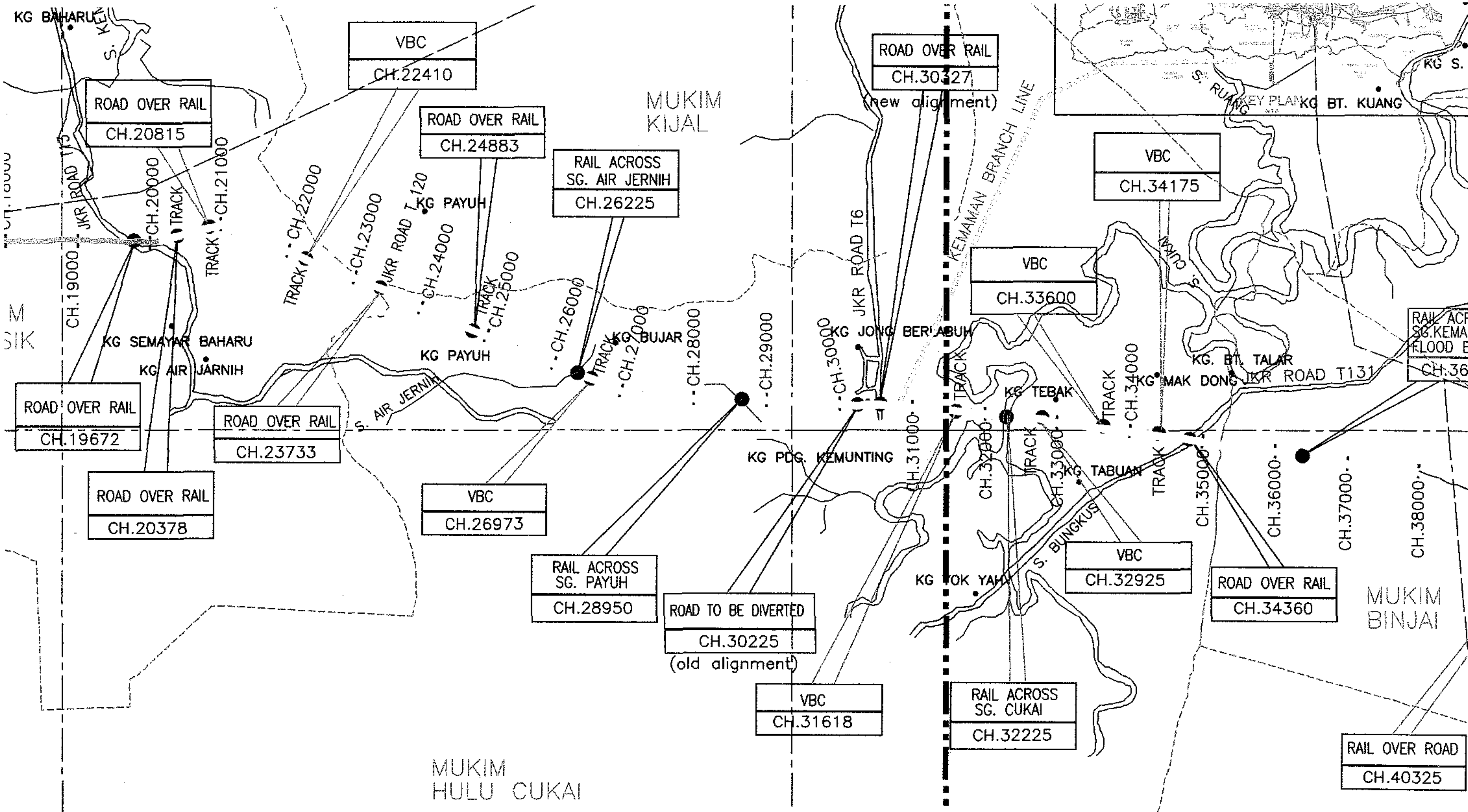
AS - BUILT DRAWING

JOB NO : S898047

CONTRACT NO : 260203/L/07/98

SCALE 1 : 75000

DRAWING NO. AB/S898047/10/LP/001-ST



PETRONAS REGISTERED LICENSED SURVEYOR

JURUKUR TEGUH

MINCONSULT SDN. BHD.

KUANTAN - KERTEH RAILWAY PROJECT

KEY PLAN AND LOCATION PLAN
(SHEET 1 OF 2)

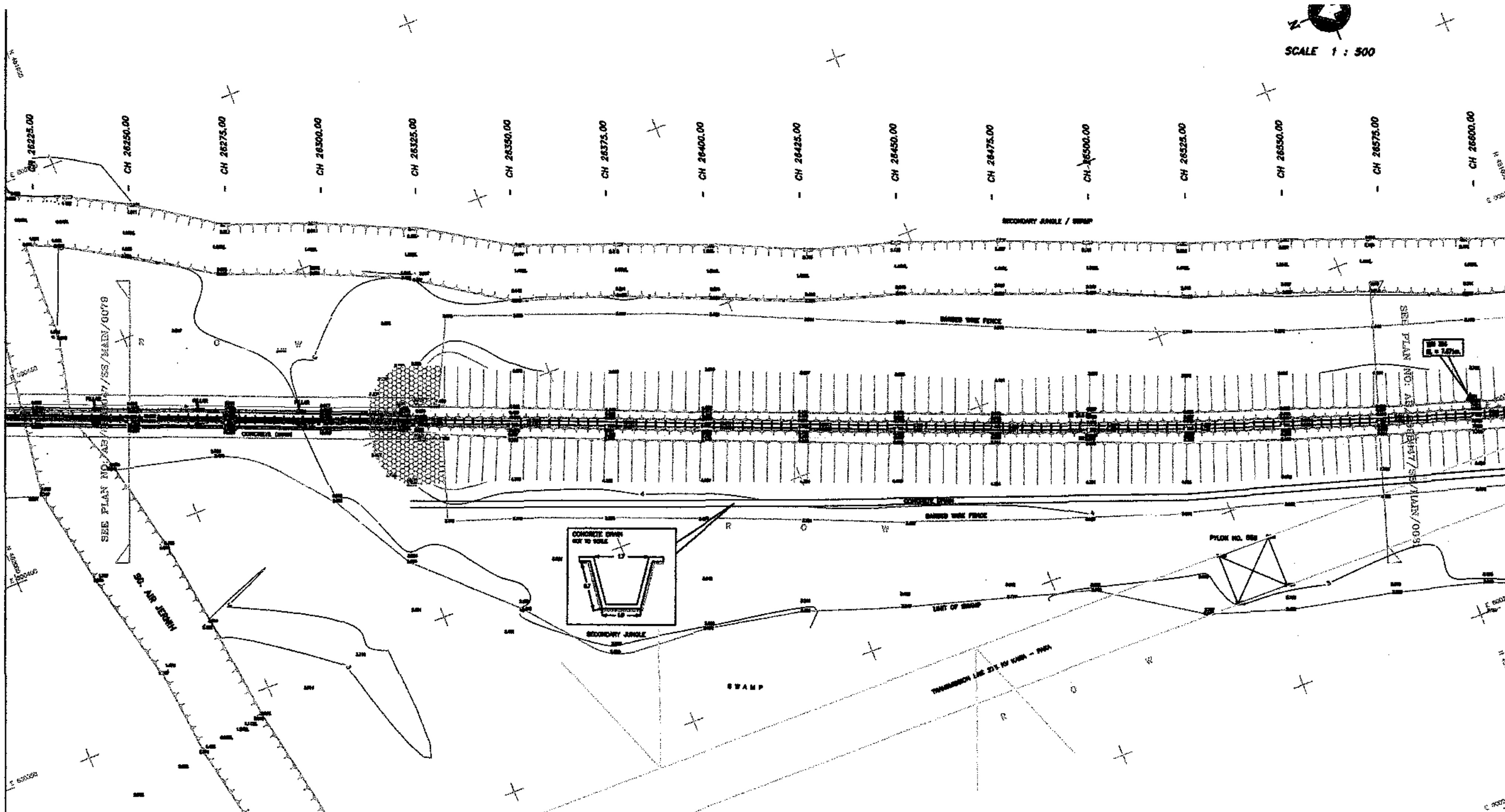
AS - BUILT DRAWING

JOB NO : 8898047

CONTRACT NO : 280203/L/07/98

1 : 75000

AB/8898047/10/LP/001-ST



NOTES :
1. GRID SHOWN ARE IN R.S.O COORDINATE SYSTEM
2. NO UNDERGROUND UTILITIES IN THE DRAWING

PETRONAS REGISTERED LICENSED SURVEYOR

JURUKUR TEGUH

MINCONSULT SDN. BHD.
LOT 6, JALAN 51A/223,
46100 PETALING JAYA, SELANGOR D.E.

JOB NO : 5596047

PETRONAS PETROLIAM NASIONAL BERHAD
TOWER 1,
PETRONAS TWIN TOWERS,
KUALA LUMPUR CITY CENTRE,
50088 KUALA LUMPUR, MALAYSIA.

CONTRACT NO : 280203/L/07/95

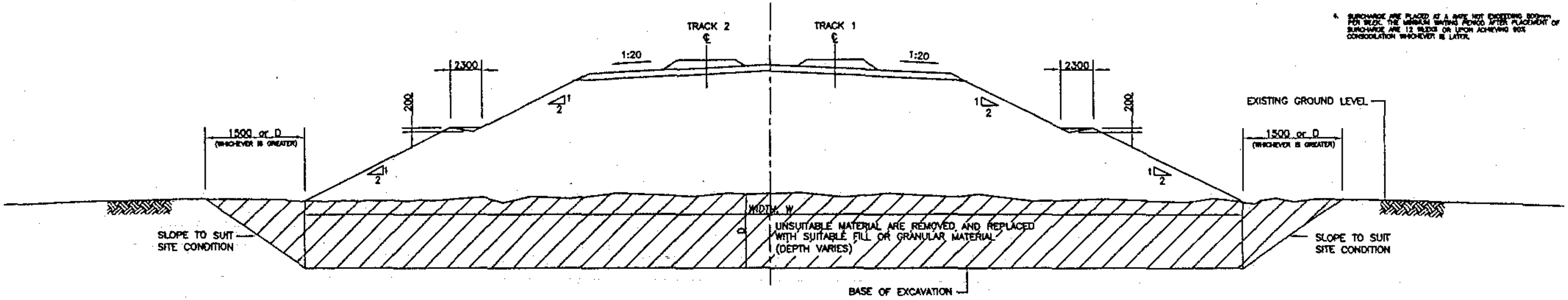
KUANTAN - KERTEH RAILWAY PROJECT

TITLE :
ALIGNMENT PLAN
(CH.26250.00 TO CH.26575.00)
AS - BUILT DRAWING

SCALE 1 : 500

DRAWING NO. AB/5596047/SS/MAIN/0080

4. SURCHARGE ARE PLACED AT A RATE NOT EXCEEDING 500mm PER WEEK. THE MINIMUM WAITING PERIOD AFTER PLACEMENT OF SURCHARGE ARE 12 WEEKS OR UPON ACHIEVING 90% CONSOLIDATION WHICHEVER IS LATER.



TYPICAL CROSS SECTION FOR REMOVAL AND REPLACEMENT OF UNSUITABLE MATERIALS

* TRACK 2 FROM CH. 29500 TO CH. 30000

N.T.S.

TABLE 1:
ALONG MAINLINE

CHAINAGE (m)		AS-CONST. DEPTH 'D' (m)	WIDTH, W (m)	REMARKS
FROM	TO			
0	650	2.0	17.5	1.5m. surcharge
650	850	2.0	66.5	1.5m. surcharge
850	1000	2.0	74.5	1.5m. surcharge
1000	1225	2.0	81.5	1.5m. surcharge
1225	1262	2.0	88.5	1.5m. surcharge
1262	1340	2.0	85.0	1.5m. surcharge
1340	1640	2.0	64.0	1.5m. surcharge
1640	1690	2.0	78.0	1.5m. surcharge
1690	1700	1.6	42.0	1.5m. surcharge
1700	1800	2.0	78.5	1.5m. surcharge
1800	2305	1.5	80.0	1.5m. surcharge
2305	2325	1.7	31.0	1.5m. surcharge
2325	2470	1.2	27.0	1.2m. surcharge
2470	2612	0.5	27.0	1.5m. surcharge
2653	2700	0.3	20.5	1.5m. surcharge
2700	3050	0.3	33.0	1.5m. surcharge
3050	3125	1.0	31.0	
3125	3300	0.3	31.0	
3230	3675	0.8	31.0	
3675	3785	1.0	22.0	1.0m. surcharge
3785	4570	0.6	30.0	
4560	4630	1.0	38.0	1.0m. surcharge
4630	4825	0.8	30.0	
4825	5000	0.3	25.0	
5270	5335	1.0	31.0	
8060	8700	2.0	35.0	1.5m. surcharge
9150	9345	0.8	22.0	1.5m. surcharge
10000	10325	0.6	22.0	
10325	10360	1.0	22.5	1.0m. surcharge
10360	10450	0.7	22.5	
10450	10600	0.4	20.5	
10600	10675	1.5	16.5	
10790	10810	1.3	18.0	
10810	10910	3.0	18.0	
10910	11030	2.0	14.0	
11030	11180	1.7	23.5	
11180	11250	1.9	25.3	

TABLE 1:
ALONG MAINLINE

CHAINAGE (m)		AS-CONST. DEPTH 'D' (m)	WIDTH, W (m)	REMARKS
FROM	TO			
11250	11425	1.0	26.5	
11425	11565	1.0	32.5	1.0m. surcharge
11725	11845	1.0	32.0	
12165	12225	1.0	32.0	
12735	12810	1.0	32.0	
12865	12875	1.0	32.0	
12530	12975	2.5	32.0	
12975	13025	3.5	32.0	
13025	13125	2.8	27.0	
13125	13275	2.0	23.5	
13275	13325	3.0	23.5	
13325	13388	3.5	23.5	
13388	13825	2.5	14.0	
13825	13850	2.5	13.0	
13850	13875	1.5	13.0	
13825	13836	1.5	13.0	
13836	13850	1.8	13.0	
13850	13875	1.8	13.0	
13875	14000	2.5	12.0	
14000	14175	3.0	11.5	
14175	14380	5.0	10.0	
14380	14650	4.0	8.5	
14650	14725	3.0	10.0	
14725	14775	2.0	10.0	
14775	14825	0.8	8.5	
14825	15000	1.0	17.5	
15000	15240	1.0	16.5	
15240	15270	1.0	8.5	
15270	15472	1.2	16.5	
15472	15640	1.2	10.5	
16125	16210	1.0	9.0	
16210	16280	1.0	11.5	
16280	16325	1.2	13.5	
16325	16560	1.2	15.0	
16560	16675	1.0	8.5	
17160	17180	2.4	4.0	
17180	17210	1.8	19.0	

ALONG MAINLINE

CHAINAGE (m)		AS-CONST. DEPTH 'D' (m)	WIDTH, W (m)	REMARKS
FROM	TO			
17410	17460	2.0	18.0	
17460	17650	1.0	16.0	
17650	17700	2.0	16.5	
17700	17781	0.8	18.5	
17840	17935	1.0	14.3	
18045	18075	2.0	13.5	
18075	18085	2.0	14.5	
18085	18210	3.0	14.5	
18210	18270	1.0	14.5	
18460	18580	1.3	16.8	
18580	18660	1.6	17.0	
18660	18675	1.4	18.5	
18675	19065	1.4	19.3	
19235	19340	2.8	16.5	2.0m SURCHARGE
19340	19370	2.6	16.5	
19370	19410	2.5	16.5	2.0m SURCHARGE
19410	19580	1.6	15.0	
19580	19618	0.6	12.8	
19835	20000	2.5	16.0	2.0m SURCHARGE
20000	20275	3.0	15.5	2.0m SURCHARGE
20275	20425	3.5	14.0	2.0m SURCHARGE
20425	20550	3.5	14.5	2.0m SURCHARGE
20550	20775	3.0	15.5	2.0m SURCHARGE
20775	20800	3.0	15.5	2.0m SURCHARGE
20825	20880	3.0	30.0	
22475	23175	0.8	25.0	
23175	23300	0.6	20.0	
23300	23487	3.2	20.0	
23487	23825	1.6	20.0	
23825	23870	0.6	20.0	
23960	24000	3.0	16.5	1.0m SURCHARGE
24000	24040	1.0	17.0	1.0m SURCHARGE
24040	24370	1.0	17.0	
24370	24500	2.5	17.0	1.0m SURCHARGE
24500	24700	3.5	14.3	1.0m SURCHARGE
24700	24860	3.5	18.1	1.0m SURCHARGE
24860	25050	2.4	15.0	
25050	25200	2.0	15.5	

ALONG MAINLINE

CHAINAGE (m)		AS-CONST. DEPTH 'D' (m)	WIDTH, W (m)	REMARKS
FROM	TO			
25200	25300	2.1	15.5	
25300	25400	2.0	11.5	
25400	25460	1.8	10.0	
25460	25600	1.6	9.5	
25450	25900	1.0	25.5	
25900	26107	1.0	36.5	
26347	26500	2.6	37.5	
26500	26675	2.0	38.5	
26675	27100	2.6	22.5	
27100	27300	2.9	17.5	
27300	27850	1.5	20.0	1.0m SURCHARGE
28050	28630	1.2	37.5	
29400	30000	0.4	37.5	

BRIDGE	CHAINAGE (m)		DEPTH 'D' (m)	WIDTH 'W' (m)	REMARKS
	FROM	TO			
ALONG ROAD OVER RAIL AT CH. 15250	30	90	2.0	22.5	
	410	472	2.0	22.0	
ALONG ROAD OVER RAIL AT CH. 16175	50	140	2.0	17.0	
	465	505	2.0	18.0	
ALONG ROAD OVER RAIL AT CH. 19872	280	290.75	1.5	41.8	
	309.25	480	1.8	39.5	
	480	560	1.8	30.5	
ALONG ROAD OVER RAIL AT CH. 20378	30	108	2.0	15.0	
	330.0	335	2.0	42.0	
ALONG ROAD OVER RAIL AT CH. 20915	10.0	90.0	1.0	16.0	
	90.0	280.0	2.0	35.0	
	280.0	460.0	1.0	20.0	
ALONG ROAD OVER RAIL AT CH. 24883	91.4	164.4	1.5	36.5	
	412.1	428.1	1.5	16.0	1.0m SURCHARGE

ACCESS ROAD NO.1 AT KERTEH YARD (CH.1025m)

CHAINAGE (m)		DEPTH 'D' (m)	WIDTH 'W' (m)	REMARKS
FROM	TO			
108	120	2.0	26.5	
120	130	2.0	30.0	
130	140	2.0	34.5	

ACCESS ROAD NO.2 AT KERTEH YARD (CH.1575m)

CHAINAGE (m)		DEPTH 'D' (m)	WIDTH 'W' (m)	REMARKS
FROM	TO			
107	120	2.0	38.0	
120	126	2.0	46.5	
126	163	2.0	60.0	

CONTRACTOR :

PERCON *BABENA* JOINT VENTURE
9th & 15th Floor, Menara PNB,
Jalan Tun Razak,
50400 KUALA LUMPUR.
P.O. Box 12309, 50766 KUALA LUMPUR, MALAYSIA.

NO	DATE	DESCRIPTION	DRAWN	REVIEWED

CONFIDENTIAL. Not to be disclosed, used, duplicated or retained except as permitted in writing.

DATE : APRIL 2002
PERCON-BABENA JOINT VENTURE :
PROJECT MANAGER
PETRONAS JOB NO : 260203/L/07/98

PETRONAS REGISTERED LICENSED SURVEYOR
JURUKUR BUDIMAN
470 E, Tingkat Batu & Dua,
Jalan Kamaruddin,
20400 Kuala Terengganu,
Terengganu Darul Iman.
JOB NO : 5698047

PETRONAS PETROLIAM NASIONAL BERHAD
MENARA 1,
MENARA BERKEMBAR PETRONAS,
KUALA LUMPUR CITY CENTRE,
50088 KUALA LUMPUR, MALAYSIA.

AS-BUILT DRAWING

MINCONSULT SDN. BHD.
(COMPANY No. 58635-P)

KUANTAN - KERTEH RAILWAY PROJECT

TITLE : GROUND IMPROVEMENT WORKS - REMOVAL/REPLACEMENT
AS - CONSTRUCTED DRAWINGS

SCALE : AS SHOWN
DRAWING NO. AC/5698047/28/GIMP/009-ST

ALONG MAINLINE

CHAINAGE (m)		AS-CONST. DEPTH 'D' (m)	WIDTH, W (m)	REMARKS
FROM	TO			
25200	25300	2.1	15.5	
25300	25400	2.0	11.5	
25400	25450	1.8	10.0	
25450	25500	1.5	9.5	
25650	25900	1.0	25.5	
25900	26107	1.0	36.5	
26347	26500	2.5	37.5	
26500	26675	2.0	35.5	
26675	27100	2.5	22.5	
27100	27300	2.5	17.5	
27300	27850	1.5	20.0	1.0m SURCHARGE
28550	28830	1.2	37.5	
29400	30000	0.4	37.5	

BRIDGE	CHAINAGE (m)		DEPTH 'D' (m)	WIDTH 'W' (m)	REMARKS
	FROM	TO			
ALONG ROAD OVER RAIL AT CH. 15256	30	90	2.0	22.5	
	410	472	2.0	22.0	
ALONG ROAD OVER RAIL AT CH. 16175	50	140	2.0	17.0	
	465	505	2.0	16.0	
ALONG ROAD OVER RAIL AT CH. 19672	250	260.75	1.5	41.5	
	399.25	480	1.5	39.5	
	480	560	1.5	30.5	
ALONG ROAD OVER RAIL AT CH. 20378	30	100	2.0	15.0	
	330.0	335	2.0	42.0	
ALONG ROAD OVER RAIL AT CH. 20815	10.0	90.0	1.0	16.0	
	90.0	280.0	2.0	35.0	
	280.0	460.0	1.0	20.0	
ALONG ROAD OVER RAIL AT CH. 24883	91.4	184.4	1.5	39.5	
	412.1	428.1	1.5	18.0	1.0m SURCHARGE

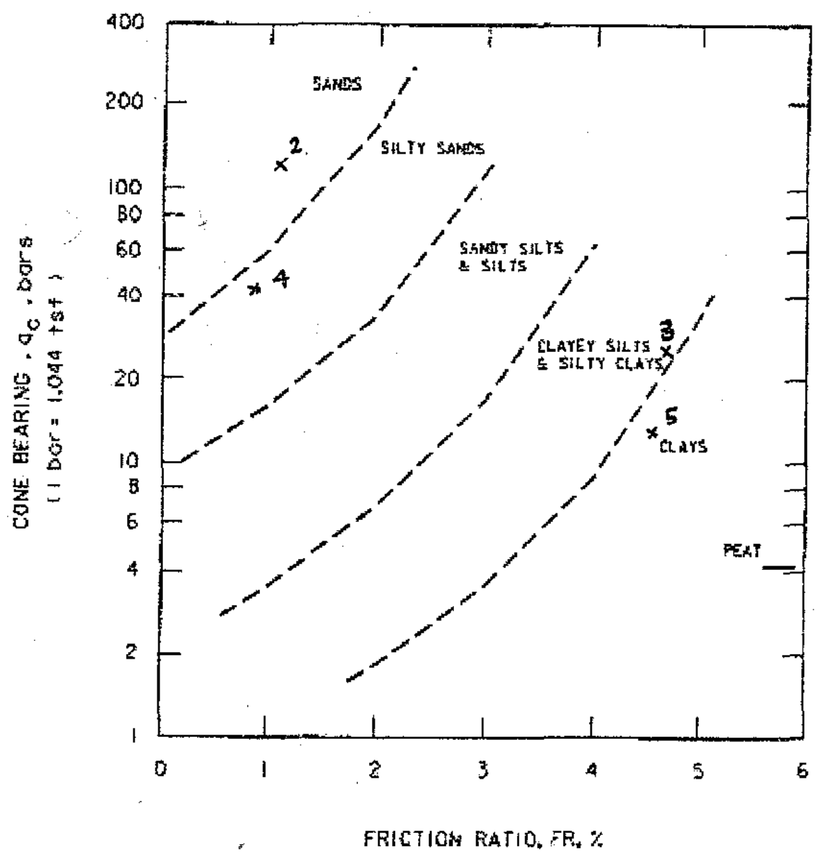
Appendix B

Robertson & Campanella (1983) vs. Schmertmann (1978) Soil Profiling Chart

CPT : 13

CH : 26747 (east)

Soil Classification From Cone Penetrometer
(Robertson and Campanella 1983)



× 1

1bar =

Remarks:

Layer 1 - Clays

Layer 2 - Sands

Layer 3 - Silty clays

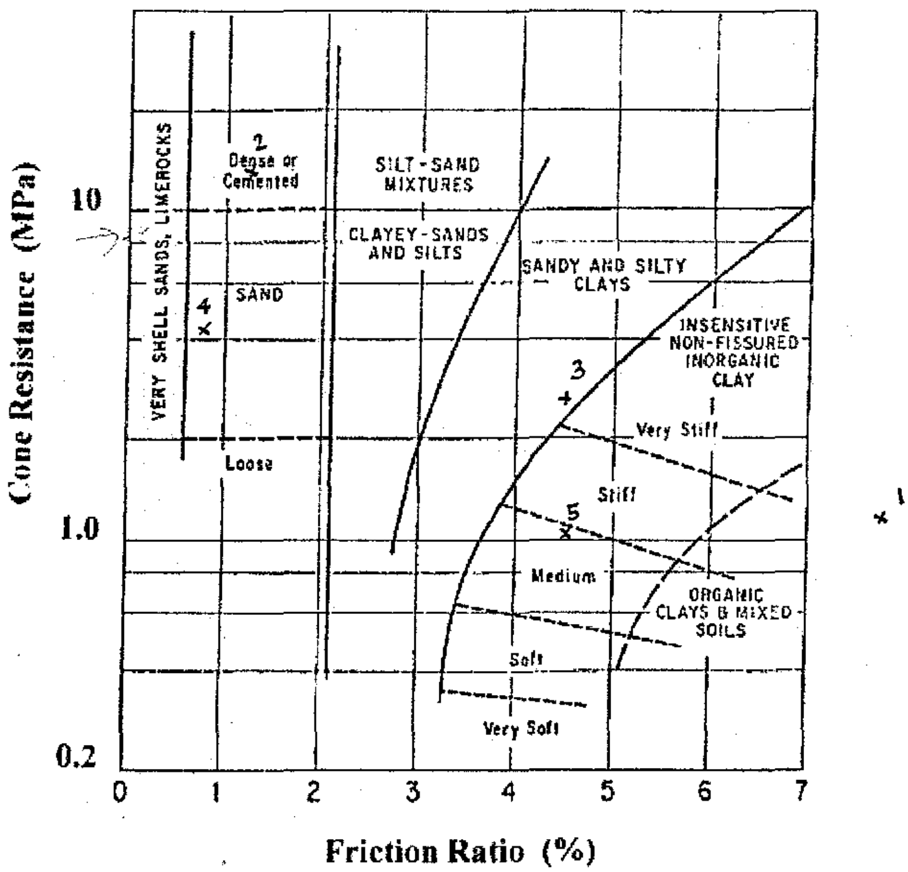
Layer 4 - Silty sands

Layer 5 - Clays.

CPT : 13

CH : 26747 (east)

The Schmertmann Profiling Chart
(Schmertmann, 1978)



Remarks:

Layer 1 - Organic Clays

Layer 2 - Dense Sand

Layer 3 - Silty Clay

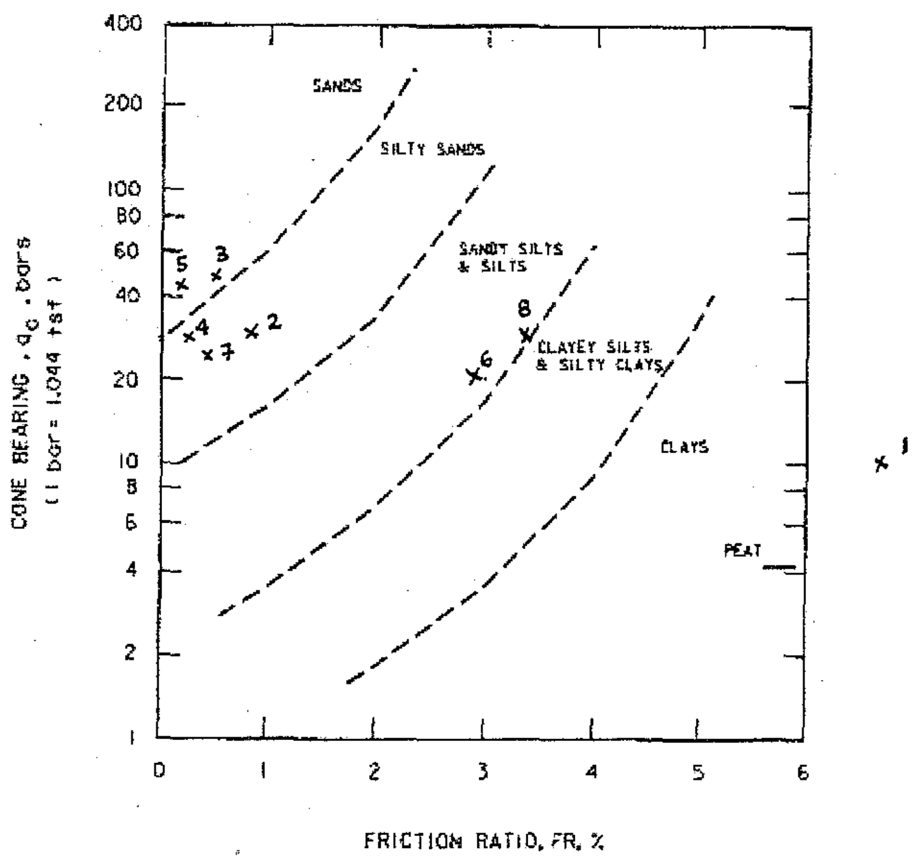
Layer 4 - Medium dense Sand

Layer 5 - Medium dense Clay.

CPT : 14

CH : 26640 (west)

Soil Classification From Cone Penetrometer
(Robertson and Campanella 1983)



Remarks:

Layer 1 - Clay

Layer 2 - silty sands

Layer 3 - sand

Layer 4 - silty sands

Layer 5 - sand

Layer 6 - sandy silt

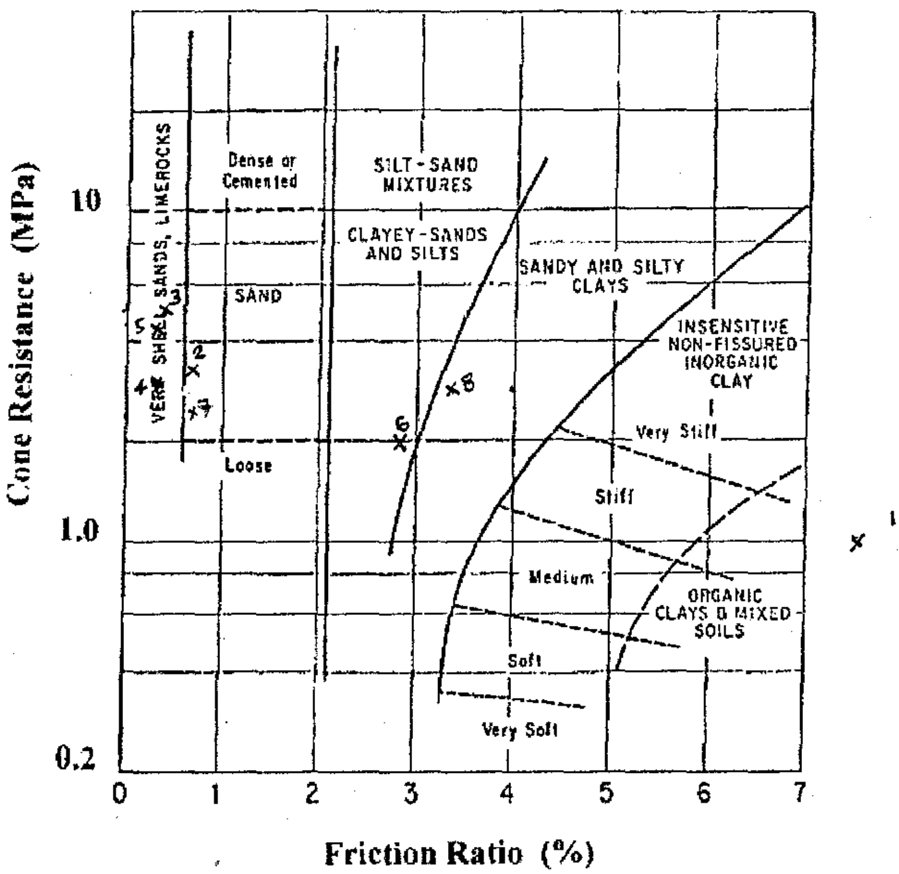
Layer 7 - silty sand

Layer 8 - silts

CPT : 14

CH : 26640 (West)

The Schmertmann Profiling Chart
(Schmertmann, 1978)



Remarks:

Layer 1 - Organic clay

Layer 2 - Medium dense sand

Layer 3 - very shell sands, limerocks

Layer 4 - very shell sands, limerocks

Layer 5 - very shell sands, limerocks

Layer 6 - Clayey sand & silts

Layer 7 - Medium sand

Layer 8 - Sandy & Silty Clays.

OUNDING DATA IN FILE CPT166 07-14-05 17:32

PERATOR : FRANCIS TAY   LOCATION : KERTEH CH26.747

ONE ID : 793TC   JOB No. : CP-13 (3.90mL)

OSMIC ACCORD SDN.BHD.

EPTH eters	TIP Qc MPa	FRICTION Fs kPa	FR RATIO Fs/Qc %	PORE PR Pw kPa	P P RATIO Pw/Qc %	INC I deg	INTERPRETED SOIL TYPE	N SPT
0.05	0.34	15.0	4.48	-5	-1.59	0.0	?	?
0.10	0.86	29.5	3.43	-4	-0.42	0.0	clay	9
0.15	1.54	58.7	3.82	-3	-0.22	0.0	clayey silt to silty clay	9
0.20	2.71	80.2	2.96	-4	-0.13	0.0	clayey silt to silty clay	12
0.25	3.04	91.1	3.00	-4	-0.12	0.0	clayey silt to silty clay	13
0.30	2.30	83.7	3.63	-4	-0.19	0.0	clayey silt to silty clay	11
0.35	1.53	69.2	4.53	-5	-0.33	0.0	clay	17
0.40	1.27	69.7	5.48	-4	-0.35	0.0	clay	13
0.45	1.21	68.0	5.61	-3	-0.28	0.0	clay	12
0.50	1.07	58.6	5.49	-3	-0.31	0.0	clay	10
0.55	0.86	45.3	5.26	-4	-0.42	0.0	clay	9
0.60	0.73	42.1	5.74	-3	-0.46	0.0	clay	8
0.65	0.79	43.3	5.48	-3	-0.43	0.0	clay	8
0.70	0.86	51.7	6.03	-4	-0.42	0.0	clay	9
0.75	1.12	73.6	6.57	-4	-0.36	0.0	clay	12
0.80	1.60	93.0	5.81	-13	-0.83	0.0	clay	15
0.85	1.81	100.9	5.58	-30	-1.68	0.0	clay	17
0.90	1.77	97.8	5.53	-62	-3.53	0.0	clay	16
0.95	1.35	79.4	5.89	-63	-4.66	0.0	clay	14
1.00	0.97	52.6	5.41	-26	-2.68	0.0	clay	10
1.05	0.69	42.1	6.07	-13	-1.85	0.0	clay	7
1.10	0.50	34.3	6.86	-12	-2.49	0.0	clay	5
1.15	0.38	31.0	8.10	-12	-3.01	0.0	organic material	4
1.20	0.34	34.1	10.10	-11	-3.32	0.0	organic material	5
1.25	0.66	47.6	7.19	-5	-0.70	0.0	clay	7
1.30	1.12	69.0	6.17	-3	-0.29	0.0	clay	10
1.35	1.09	90.7	8.33	-3	-0.30	0.0	clay	11
1.40	1.02	88.9	8.70	-13	-1.32	0.0	clay	10
1.45	0.82	70.3	8.55	-57	-5.56	0.0	clay	8
1.50	0.63	48.3	7.65	-47	-7.42	0.0	clay	7
1.55	0.54	46.3	8.52	-38	-7.04	0.0	clay	6
1.60	0.70	58.6	8.42	-33	-4.72	0.0	clay	7
1.65	0.81	76.8	9.48	-44	-5.41	0.0	organic material	8
1.70	0.96	109.5	11.35	-41	-4.26	0.0	clay	12
1.75	1.81	143.9	7.93	-35	-1.95	0.0	clay	16
1.80	2.16	159.1	7.35	-54	-2.51	0.0	clay	19
1.85	1.87	137.4	7.35	-76	-4.05	0.0	clay	18
1.90	1.46	110.8	7.58	-71	-4.88	0.0	clay	15
1.95	1.12	68.6	6.11	-68	-6.09	0.0	clay	12
2.00	0.89	57.9	6.51	-24	-2.67	0.0	clay	9

Average Value

Layer 1

Tip = 1.20 MPa

FR ratio = 8.07

Interpretation reference: Robertson & Campanella-1983, based on 60% hammer efficiency and .15 m sliding data average

DEPTH meters	TIP Qc MPa	FRICTION Fs kPa	FR RATIO Fs/Qc %	PORE PR Pw kPa	P P RATIO Pw/Qc %	INC I deg	INTERPRETED SOIL TYPE		N SPT
2.05	0.61	43.7	7.12	-10	-1.68	0.0	clay		7
2.10	0.47	39.3	8.40	-13	-2.70	0.0	clay		5
2.15	0.41	36.7	8.89	-11	-2.77	0.0	organic material		4
2.20	0.44	33.5	7.70	-5	-1.24	0.0	clay		6
2.25	0.86	35.7	4.14	-4	-0.50	0.0	clay		8
2.30	1.05	39.8	3.77	-3	-0.25	0.0	clay		9
2.35	0.92	48.3	5.25	-3	-0.34	0.0	clay		10
2.40	1.15	87.8	7.63	-0	-0.01	0.0	clay		11
2.45	1.36	103.3	7.61	-3	-0.21	0.0	clay		13
2.50	1.33	100.9	7.61	-3	-0.24	0.0	clay		13
2.55	1.11	94.1	8.50	-4	-0.39	0.0	clay		11
2.60	0.96	87.5	9.13	-6	-0.63	0.0	clay		10
2.65	0.86	77.9	9.08	-7	-0.83	0.0	clay		9
2.70	0.81	71.6	8.86	-11	-1.35	0.0	clay		9
2.75	0.99	73.4	7.42	-9	-0.93	0.0	clay		9
2.80	0.95	73.7	7.79	-35	-3.65	0.0	clay		9
2.85	0.82	71.2	8.64	-35	-4.24	0.0	clay		8
2.90	0.73	73.7	10.12	-35	-4.84	0.0	clay		8
2.95	0.95	74.8	7.86	-12	-1.29	0.0	clay		9
3.00	0.90	67.6	7.52	-27	-3.05	0.0	clay		9
3.05	0.79	64.2	8.15	-34	-4.28	0.0	clay		8
3.10	0.75	61.6	8.25	-34	-4.50	0.0	clay		7
3.15	0.67	57.0	8.51	-32	-4.73	0.0	clay		7
3.20	0.56	51.7	9.17	-38	-6.78	0.0	organic material		5
3.25	0.48	47.6	9.88	-32	-6.63	0.0	organic material		5
3.30	0.43	44.4	10.40	-26	-6.17	0.0		?	?
3.35	0.43	42.2	9.79	-10	-2.24	0.0		?	?
3.40	0.44	42.8	9.84	-14	-3.25	0.0	organic material		4
3.45	0.47	43.3	9.18	-10	-2.12	0.0	organic material		4
3.50	0.44	40.9	9.31	-13	-2.95	0.0		?	?
3.55	0.44	58.5	13.25	0	0.10	0.0		?	?
3.60	0.95	111.8	11.79	23	2.47	0.0	clay		12
3.65	2.08	154.5	7.42	-32	-1.54	0.0	clay		15
3.70	1.58	129.9	8.21	-75	-4.77	0.0	clay		16
3.75	0.98	94.6	9.61	-67	-6.80	0.0	clay		11
3.80	0.80	85.9	10.80	-61	-7.63	0.0		?	?
3.85	0.90	164.4	18.33	-53	-5.94	0.0	clay		18
3.90	3.59	234.5	6.53	-56	-1.56	0.0	clay		25
3.95	3.06	238.5	7.79	-61	-1.99	0.0	clay		30
4.00	2.19	44.4	2.02	-76	-3.47	0.0	clay		23
4.05	1.76	180.2	10.25	-83	-4.73	0.0	clay		14
4.10	0.36	143.7	40.14	-83	-23.27	0.0		?	?
4.15	1.51	128.5	8.53	-81	-5.39	0.0		?	?
4.20	1.90	164.9	8.68	-61	-3.22	0.0	clay		21
4.25	2.97	189.2	6.35	-65	-2.19	0.0	clay		23
4.30	2.05	144.6	7.04	-75	-3.64	0.0	clay		21
4.35	1.28	92.0	7.19	-74	-5.77	0.0	clay		14
4.40	0.92	70.6	7.68	-67	-7.30	0.0	clay		10
4.45	0.71	65.0	9.18	-61	-8.60	0.0	clay		8
4.50	0.64	63.3	9.90	-53	-8.34	0.0	organic material		6

EPTH eters	TIP Qc MPa	FRICTION Fs kPa	FR RATIO Fs/Qc %	PORE PR Pw kPa	P P RATIO Pw/Qc %	INC I deg	INTERPRETED SOIL TYPE	N SPT
4.55	0.56	57.3	10.17	-51	-9.12	0.0	?	?
4.60	0.52	57.8	11.11	-49	-9.44	0.0	?	?
4.65	0.57	58.6	10.35	-42	-7.38	0.0	organic material	6
4.70	0.73	53.3	7.34	-39	-5.41	0.0	organic material	6
4.75	0.48	44.0	9.20	-32	-6.62	0.0	clay	6
4.80	0.50	44.0	8.84	-15	-3.10	0.0	organic material	5
4.85	0.63	56.0	8.88	6	0.90	0.0	?	?
4.90	0.89	117.3	13.17	-29	-3.23	0.0	?	?
4.95	1.90	178.3	9.39	-34	-1.80	0.0	clay	17
5.00	2.40	219.0	9.14	-39	-1.62	0.0	clay	23
5.05	2.48	215.6	8.68	-39	-1.55	0.0	clay	25
5.10	2.52	220.7	8.77	-39	-1.53	0.0	clay	25
5.15	2.49	211.8	8.52	-13	-0.52	0.0	clay	24
5.20	2.32	191.3	8.23	-17	-0.72	0.0	clay	23
5.25	2.21	169.8	7.67	-15	-0.67	0.0	clay	22
5.30	2.03	133.4	6.58	-13	-0.62	0.0	clay	26
5.35	3.54	122.2	3.45	31	0.87	0.0	sandy silt to clayey silt	24
5.40	12.10	138.3	1.14	5	0.04	0.0	sand to silty sand	27
5.45	16.30	161.4	0.99	2	0.01	0.0	sand to silty sand	40
5.50	19.73	213.6	1.08	0	0.00	0.0	sand	38
5.55	21.54	272.2	1.26	0	0.00	0.0	sand	42
5.60	22.44	324.9	1.45	-0	-0.00	0.0	sand to silty sand	57
5.65	23.95	353.8	1.48	-9	-0.04	0.0	sand to silty sand	58
5.70	23.76	355.8	1.50	-8	-0.03	0.0	sand to silty sand	58
5.75	22.99	351.9	1.53	-7	-0.03	0.0	sand to silty sand	57
5.80	22.15	338.8	1.53	-7	-0.03	0.0	sand to silty sand	55
5.85	21.14	318.8	1.51	-4	-0.02	0.0	sand to silty sand	53
5.90	20.31	291.4	1.43	0	0.00	0.0	sand to silty sand	51
5.95	19.65	193.0	0.98	4	0.02	0.0	sand	40
6.00	19.44	162.0	0.83	4	0.02	0.0	sand	38
6.05	17.31	185.3	1.07	16	0.09	0.0	sand	35
6.10	15.66	185.2	1.18	16	0.10	0.0	sand to silty sand	39
6.15	14.39	171.0	1.19	17	0.12	0.0	sand to silty sand	36
6.20	13.08	151.3	1.16	15	0.11	0.0	sand to silty sand	33
6.25	11.79	131.9	1.12	9	0.07	0.0	sand to silty sand	29
6.30	10.51	112.6	1.07	10	0.10	0.0	sand to silty sand	26
6.35	9.48	89.0	0.94	11	0.12	0.0	sand to silty sand	24
6.40	8.73	71.6	0.82	11	0.13	0.0	sand to silty sand	22
6.45	8.65	68.1	0.79	5	0.07	0.0	sand to silty sand	22
6.50	8.42	67.8	0.80	8	0.09	0.0	sand to silty sand	21
6.55	8.10	63.5	0.78	10	0.12	0.0	sand to silty sand	20
6.60	7.73	57.5	0.75	11	0.15	0.0	sand to silty sand	19
6.65	7.38	56.6	0.77	13	0.17	0.0	sand to silty sand	18
6.70	7.03	52.4	0.75	19	0.26	0.0	sand to silty sand	18
.75	7.01	48.3	0.69	22	0.31	0.0	sand to silty sand	17
6.80	6.68	49.4	0.74	22	0.33	0.0	sand to silty sand	16
.85	5.08	55.1	1.09	22	0.44	0.0	silty sand to sandy silt	15
.90	3.03	65.5	2.16	22	0.73	0.0	sandy silt to clayey silt	13
.95	1.43	55.7	3.90	23	1.59	0.0	clayey silt to silty clay	9
.00	0.80	25.3	3.17	24	3.00	0.0	silty clay to clay	7

Layer 2
Tip = 14.05 MP
FR ratio = 1.12

Layer 3
Tip = 2.63 MPa
FR ratio = 4.53

PTH ters	TIP Qc MPa	FRICTION Fs kPa	FR RATIO Fs/Qc %	PORE PR Pw kPa	P P RATIO Pw/Qc %	INC I deg	INTERPRETED SOIL TYPE	N SPT
7.05	1.04	17.0	1.64	27	2.55	0.0	clayey silt to silty clay	5
7.10	1.12	12.1	1.09	55	4.89	0.0	clayey silt to silty clay	5
7.15	1.13	13.1	1.16	88	7.83	0.0	clayey silt to silty clay	5
7.20	0.83	21.3	2.57	101	12.22	0.0	clayey silt to silty clay	5
7.25	0.76	21.0	2.77	102	13.44	0.0	silty clay to clay	5
7.30	0.70	19.5	2.78	102	14.60	0.0	clay	7
7.35	0.63	22.2	3.50	103	16.34	0.0	clay	7
7.40	0.74	23.7	3.21	104	14.11	0.0	clay	7
7.45	0.70	24.5	3.49	105	14.89	0.0	clay	7
7.50	0.66	33.5	5.09	104	15.81	0.0	clay	7
7.55	0.80	26.6	3.33	105	13.12	0.0	clay	8
7.60	0.85	25.7	3.01	105	12.28	0.0	clay	8
7.65	0.72	25.6	3.55	105	14.57	0.0	clay	7
7.70	0.63	27.5	4.39	106	16.89	0.0	clay	7
7.75	0.64	28.4	4.42	107	16.70	0.0	clay	6
7.80	0.63	31.2	4.93	108	17.05	0.0	clay	6
7.85	0.59	33.0	5.55	108	18.31	0.0	clay	6
7.90	0.61	30.4	5.01	109	17.94	0.0	clay	6
7.95	0.56	24.2	4.36	109	19.65	0.0	clay	5
8.00	0.48	25.0	5.19	110	22.81	0.0	clay	5
8.05	0.63	24.5	3.88	94	14.87	0.0	clay	6
8.10	0.76	24.9	3.27	95	12.51	0.0	clay	7
8.15	0.71	28.6	4.01	98	13.69	0.0	clay	7
8.20	0.65	21.9	3.37	98	15.08	0.0	clay	7
8.25	0.71	25.1	3.54	100	14.07	0.0	clay	7
8.30	0.83	26.8	3.24	99	11.99	0.0	clay	8
8.35	0.83	32.5	3.93	99	12.01	0.0	clay	9
8.40	0.95	41.0	4.33	101	10.65	0.0	clay	10
8.45	1.17	51.2	4.37	100	8.49	0.0	clay	11
8.50	1.19	63.8	5.34	96	8.06	0.0	clay	12
8.55	1.12	68.1	6.07	92	8.22	0.0	clay	12
8.60	1.15	76.7	6.67	92	7.97	0.0	clay	11
8.65	1.12	88.1	7.87	87	7.77	0.0	clay	11
8.70	1.15	75.7	6.51	87	7.53	0.0	clay	11
8.75	0.96	68.2	7.12	87	9.08	0.0	clay	10
8.80	0.96	65.2	6.82	88	9.15	0.0	clay	10
8.85	1.12	69.9	6.25	87	7.77	0.0	clay	11
8.90	1.10	68.6	6.26	83	7.57	0.0	clay	11
.95	1.13	68.1	6.01	84	7.43	0.0	clay	11
.00	1.17	71.7	6.12	84	7.16	0.0	clay	12
.05	1.35	81.8	6.08	78	5.81	0.0	clay	12
.10	1.21	97.1	8.03	79	6.53	0.0	clay	13
.15	1.28	94.7	7.38	76	5.93	0.0	clay	12
.20	1.20	69.6	5.80	76	6.33	0.0	clay	12
.25	1.15	59.9	5.22	78	6.76	0.0	clay	12
.30	1.17	67.6	5.80	78	6.65	0.0	clay	12
.35	1.28	71.1	5.55	77	5.99	0.0	clay	12
.40	1.25	74.0	5.92	76	6.08	0.0	clay	13
.45	1.31	71.0	5.40	77	5.84	0.0	clay	13
.50	1.31	76.8	5.86	74	5.65	0.0	clay	13

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DEPTH meters	TIP Qc MPa	FRICTION Fs kPa	FR RATIO Fs/Qc %	PORE PR Pw kPa	P P RATIO Pw/Qc %	INC I deg	INTERPRETED SOIL TYPE	N SPT
9.55	1.27	69.4	5.46	73	5.73	0.0	clay	13
9.60	1.34	76.4	5.68	75	5.59	0.0	clay	13
9.65	1.41	80.1	5.66	74	5.24	0.0	clay	14
9.70	1.41	75.4	5.33	73	5.19	0.0	clay	14
9.75	1.30	58.5	4.50	74	5.70	0.0	clay	13
9.80	1.24	51.8	4.17	75	6.05	0.0	clay	13
9.85	1.27	49.9	3.92	76	6.00	0.0	clay	13
9.90	1.26	52.8	4.19	77	6.14	0.0	clay	13
9.95	1.25	55.3	4.42	79	6.29	0.0	clay	12
10.00	1.19	46.9	3.95	80	6.69	0.0	clay	12
10.05	1.15	56.3	4.89	81	7.02	0.0	clay	12
10.10	1.41	68.3	4.86	91	6.46	0.0	clay	13
10.15	1.41	73.2	5.20	89	6.33	0.0	clay	13
10.20	1.17	58.7	5.03	88	7.53	0.0	clay	13
10.25	1.25	50.0	4.02	90	7.26	0.0	clay	12
10.30	1.19	52.3	4.41	92	7.73	0.0	clay	13
10.35	1.37	51.1	3.72	93	6.74	0.0	clay	12
10.40	1.03	36.6	3.57	87	8.50	0.0	clay	11
10.45	0.96	42.2	4.38	88	9.13	0.0	clay	10
10.50	1.06	40.8	3.85	90	8.52	0.0	silty clay to clay	8
10.55	1.38	28.7	2.07	92	6.64	0.0	silty clay to clay	8
10.60	0.99	33.0	3.31	94	9.43	0.0	clayey silt to silty clay	6
10.65	1.21	29.6	2.44	97	8.00	0.0	clayey silt to silty clay	6
10.70	1.39	15.2	1.10	91	6.56	0.0	clayey silt to silty clay	6
10.75	0.79	30.4	3.86	93	11.80	0.0	silty clay to clay	7
10.80	0.96	44.7	4.65	97	10.10	0.0	clayey silt to silty clay	9
10.85	3.41	42.1	1.24	71	2.08	0.0	sandy silt to clayey silt	10
10.90	3.46	19.9	0.58	1	0.02	0.0	silty sand to sandy silt	11
10.95	2.79	12.3	0.44	-7	-0.25	0.0	silty sand to sandy silt	9
11.00	1.61	12.1	0.75	-4	-0.24	0.0	sandy silt to clayey silt	8
11.05	1.35	8.7	0.64	-3	-0.21	0.0	sandy silt to clayey silt	6
11.10	1.59	3.7	0.23	10	0.62	0.0	sandy silt to clayey silt	5
11.15	1.14	9.9	0.87	10	0.89	0.0	sandy silt to clayey silt	5
11.20	0.91	18.2	2.02	11	1.24	0.0	sandy silt to clayey silt	6
11.25	2.23	22.6	1.02	13	0.60	0.1	silty sand to sandy silt	10
11.30	6.06	26.0	0.43	15	0.25	0.1	sand to silty sand	19
11.35	8.46	31.4	0.37	17	0.20	0.1	sand to silty sand	21
11.40	10.45	37.7	0.36	18	0.17	0.1	sand	19
11.45	9.55	53.6	0.56	17	0.18	0.1	sand to silty sand	22
11.50	6.19	59.2	0.96	20	0.33	0.1	sand to silty sand	16
11.55	3.15	48.6	1.54	21	0.69	0.1	silty sand to sandy silt	12
11.60	1.33	36.2	2.72	25	1.87	0.1	clayey silt to silty clay	5
11.65	0.89	34.7	3.88	30	3.36	0.1	clay	10
11.70	0.82	37.1	4.54	34	4.13	0.1	clay	8
11.75	0.83	37.3	4.51	36	4.42	0.1	clay	8
11.80	0.84	37.3	4.43	39	4.61	0.1	clay	8
11.85	0.82	35.9	4.36	42	5.05	0.1	clay	8
11.90	0.81	36.4	4.49	44	5.46	0.1	clay	8
11.95	0.86	38.9	4.51	48	5.56	0.1	clay	8
12.00	0.87	49.0	5.65	52	5.96	0.1	clay	8

Layer 4
Tip = 4.16 MPa
FR ratio = 0.80

Layer 5
Tip = 1.12 MPa
FR ratio = 4.63

TH ters	TIP Qc MPa	FRICTION Fs kPa	FR RATIO Fs/Qc %	PORE PR Pw kPa	P P RATIO Pw/Qc %	INC I deg	INTERPRETED SOIL TYPE	N SPT
.05	0.76	42.8	5.63	55	7.17	0.1	clay	8
.10	0.73	30.1	4.11	116	15.90	0.1	clay	7
.15	0.70	23.8	3.40	123	17.53	0.1	clay	7
.20	0.76	28.3	3.71	129	16.92	0.1	clay	8
.25	0.87	32.6	3.74	136	15.57	0.1	clay	8
.30	0.86	31.6	3.67	143	16.57	0.1	clay	9
.35	0.85	32.2	3.77	154	17.98	0.1	clay	9
.40	0.90	36.5	4.04	164	18.13	0.1	clay	9
.45	0.95	38.8	4.09	173	18.25	0.1	clay	9
.50	0.90	35.9	4.00	182	20.26	0.1	clay	9
.55	0.89	31.5	3.54	190	21.42	0.1	clay	9
.60	0.89	34.1	3.84	200	22.54	0.1	clay	9
.65	0.95	37.5	3.94	213	22.43	0.1	clay	9
.70	0.93	37.7	4.03	224	23.96	0.1	clay	9
.75	0.94	35.8	3.81	236	25.04	0.1	clay	10
.80	0.99	41.6	4.21	250	25.29	0.2	clay	10
.85	1.05	45.9	4.38	266	25.35	0.2	clay	10
.90	1.08	49.6	4.58	279	25.78	0.2	clay	11
.95	1.09	51.9	4.78	293	26.95	0.2	clay	11
.00	1.09	80.8	7.40	307	28.07	0.2	clay	11
.05	1.08	74.8	6.92	315	29.12	0.2	clay	12
.10	1.31	65.7	5.00	91	6.96	0.2	clay	12
.15	1.29	63.4	4.93	99	7.69	0.2	clay	14
.20	1.51	70.5	4.67	108	7.13	0.2	clay	15
.25	1.77	96.1	5.42	118	6.65	0.2	clay	20
.30	2.65	181.5	6.86	130	4.93	0.2	clay	28
.35	3.98	364.4	9.15	146	3.66	0.2	clay	46
.40	7.03	486.6	6.93	135	1.92	0.2	?	?
.45	12.18	?	?	78	0.64	0.3	?	?
.50	21.11	?	?	13	0.06	0.3	?	?

interpretation reference: Robertson & Campanella-1983, based on 60% hammer efficiency and .15 m sliding data average

UNDING DATA IN FILE CPT166 07-14-05 17:32

ERATOR : FRANCIS TAY　　　　LOCATION : KERTEH CH26.747

NE ID : 793TC　　　　JOB No. : CP-13 (3.90mL)

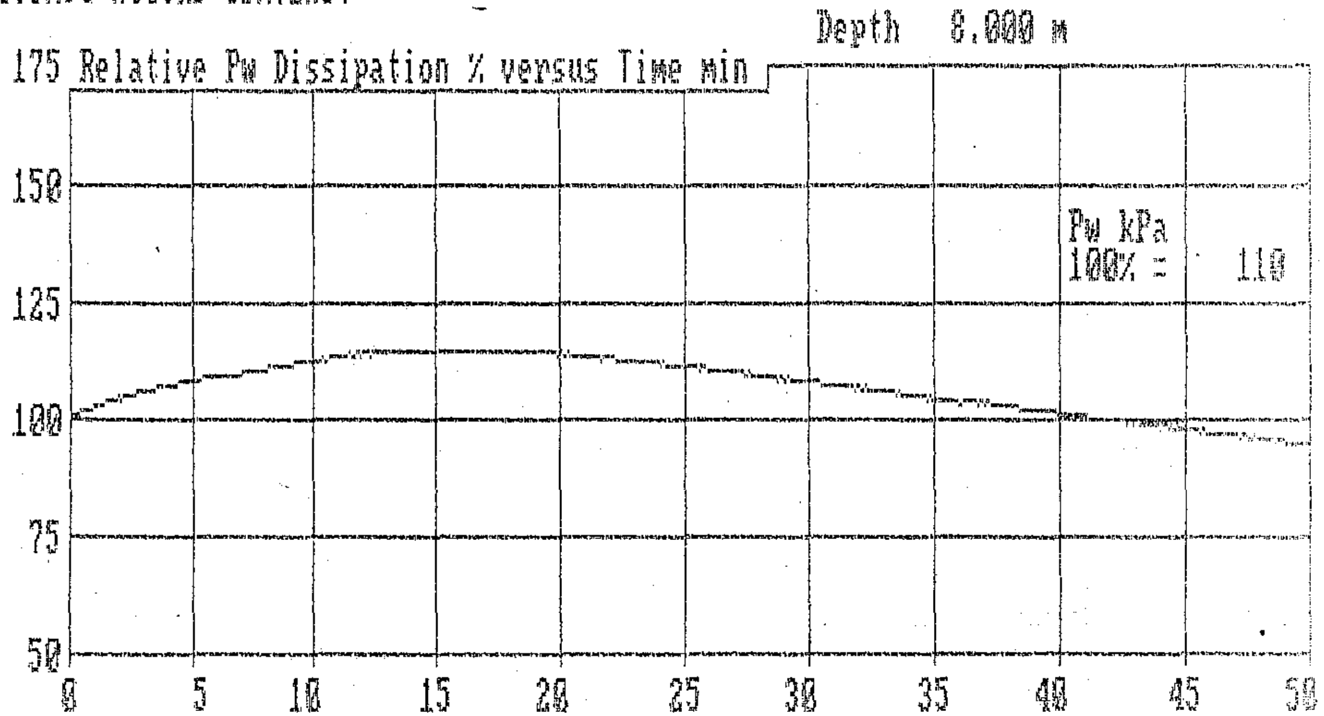
SMIC ACCORD SDN.BHD.

PTH meters	DEPTH feet	TIME sec	DISSIPATION OF Pw kPa AT INTERVAL 5 sec											
8.00	26.2	0.0	110	111	112	112	112	112	112	113	113	113	113	113
		60.0	114	114	114	114	114	115	115	115	115	115	116	116
		120.0	116	116	116	116	116	117	117	117	117	117	117	117
		180.0	117	117	118	118	118	118	118	118	118	118	118	119
		240.0	119	119	119	119	119	119	119	119	119	120	119	120
		300.0	120	120	120	120	120	120	120	120	120	121	121	121
		360.0	120	121	121	121	121	121	121	121	121	121	121	121
		420.0	121	122	122	122	122	122	122	122	122	122	122	122
		480.0	123	123	123	123	123	123	123	123	123	123	123	124
		540.0	124	124	124	124	124	124	124	124	124	124	124	124
		600.0	124	124	125	125	125	125	125	125	125	125	125	125
		660.0	126	125	125	125	126	126	126	125	126	126	126	126
		720.0	126	126	126	126	126	126	127	126	126	126	126	126
		780.0	126	126	127	127	127	127	127	127	127	127	127	127
		840.0	127	127	127	127	127	127	127	127	127	127	127	127
		900.0	127	127	127	127	127	127	127	127	127	127	127	127
		960.0	127	127	127	127	127	127	127	127	127	127	127	127
		1020.0	127	127	127	127	127	127	127	127	127	127	127	126
		1080.0	127	127	127	127	127	127	127	126	126	127	127	126
		1140.0	126	126	126	126	126	126	126	126	126	126	126	126
		1200.0	126	126	126	126	126	126	126	126	126	126	125	126
		1260.0	125	125	125	125	126	126	125	125	125	125	125	125
		1320.0	125	125	125	125	125	125	125	125	124	124	124	125
		1380.0	124	124	124	124	124	124	124	124	124	124	124	124
		1440.0	124	124	124	124	123	124	124	123	123	123	123	123
		1500.0	123	123	123	123	123	123	123	123	123	123	123	122
		1560.0	122	122	122	122	122	122	122	122	122	122	122	122
		1620.0	122	122	122	121	121	121	121	121	121	121	121	121
		1680.0	121	121	121	121	121	121	120	120	121	120	120	120
		1740.0	120	120	120	120	120	120	120	120	120	120	120	120
		1800.0	120	120	119	119	119	119	119	119	119	119	119	119
		1860.0	119	119	119	119	118	119	118	118	118	118	118	118
		1920.0	118	118	118	118	118	118	118	117	117	118	117	117
		1980.0	117	117	117	117	117	117	117	117	117	117	117	116
		2040.0	116	116	115	116	116	116	115	116	116	116	115	115
		2100.0	115	116	115	116	115	115	115	115	115	115	115	115
		2160.0	114	114	115	115	115	115	115	115	115	114	115	115
		2220.0	114	115	115	114	114	114	114	114	114	114	114	114
		2280.0	114	113	114	113	113	113	113	113	113	113	113	113
		2340.0	113	113	113	113	113	113	113	112	112	112	112	112
		2400.0	112	112	112	112	112	112	112	112	112	112	111	111

PTH ters	DEPTH feet	TIME sec	DISSIPATION OF Pw kPa AT INTERVAL 5 sec											
8.00	26.2	2460.0	111	111	111	111	111	111	111	111	111	111	111	110
		2520.0	110	111	110	110	110	110	110	110	110	110	110	110
		2580.0	110	110	110	109	110	109	109	109	109	109	109	109
		2640.0	105	109	109	109	109	109	109	108	109	108	108	108
		2700.0	108	108	108	108	108	108	108	107	108	108	107	108
		2760.0	107	107	107	107	107	107	107	107	107	107	107	107
		2820.0	107	106	106	106	106	107	106	106	106	106	106	106
		2880.0	106	106	106	106	106	105	105	105	105	105	105	105
		2940.0	105	105	105	105	105	105	105	105	105	105	105	105
		3000.0	104	104	104	104	104	104	104	104	104	104	104	104
		3060.0	103	104	103	103	104	104	103	103	103	103	103	103
		3120.0	103	103	103	103	103	103	103	102	102	102	102	102
		3180.0	102	102	102	102	102	102	102	102	102	101	101	102
		3240.0	102	102	101	101	101	101	101	101	101	101	101	101
		3300.0	101	101	100	101	101	100	100	100	100	100	100	100
		3360.0	100	100	100	100	100	100	100	100	100	100	100	100
		3420.0	100	100	100	99	100	99	99	99	99	99	99	99
		3480.0	99	99	99	98	99	98	98	98	98	98	98	98
		3540.0	98	98	98	98	98	98	97	98	98	97	97	98
		3600.0	97	97	97	97								
.05	42.8	0.0	324	359	350	326	301	280	262	246	233	221	211	202
		60.0	194	187	181	175	170	165	151	157	153	150	147	144
		120.0	141	139	136	134	132	130	128	127	125	123	122	121
		180.0	119	118	117	116	114	113	112	111	111	110	109	108
		240.0	108	107	106	105	105	104	103	103	102	102	101	101
		300.0	100	100	100									

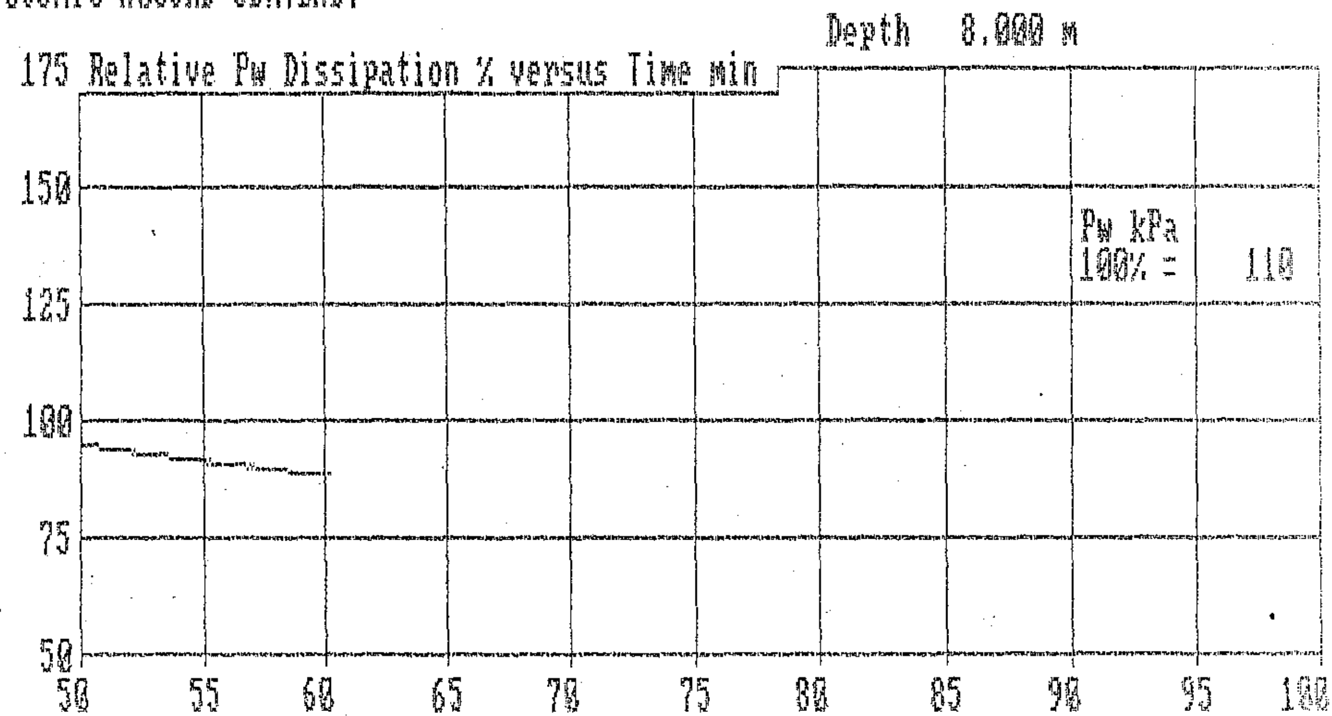
SOUNDING DATA IN FILE CPT166 07-14-05 17:32
OPERATOR : FRANCIS TAY LOCATION : KERTEH CH26.747
CONE ID : 793TC JOB No. : CP-13 (3.90mL)

COSMIC ACCORD SDN.BHD.



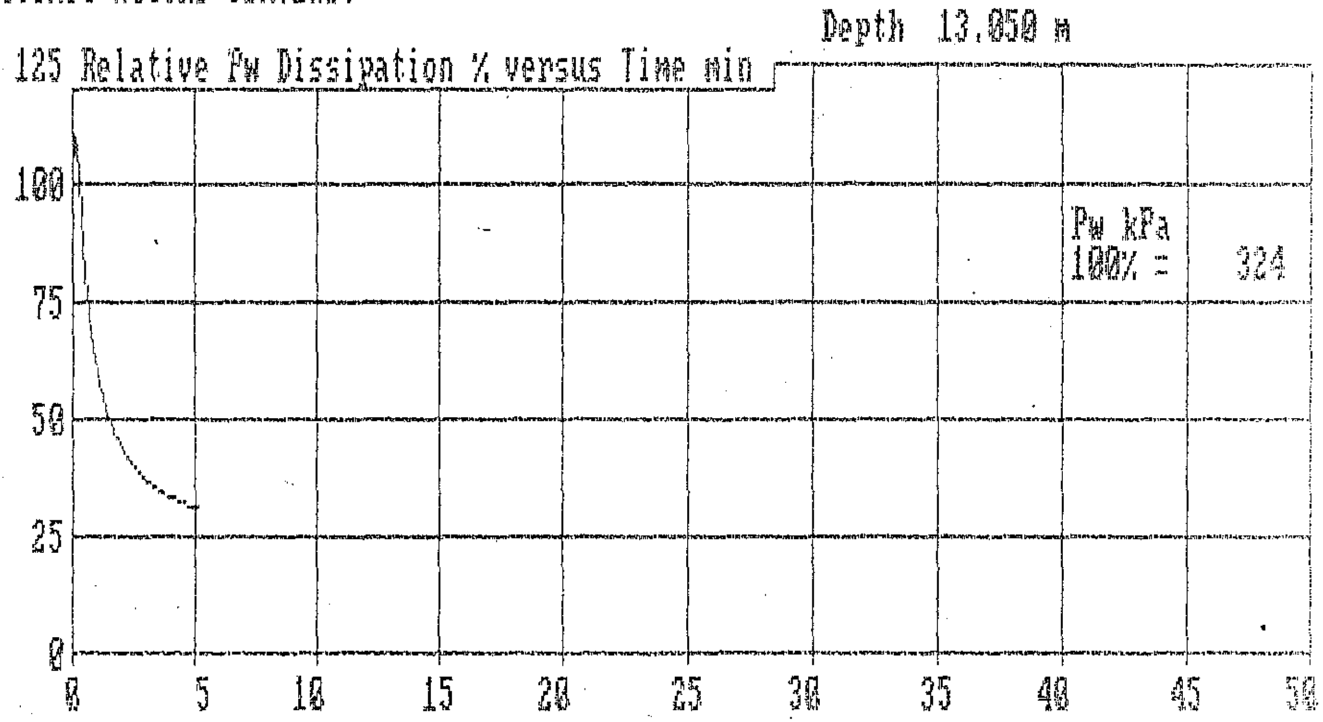
SOUNDING DATA IN FILE CPT166 07-14-05 17:32
OPERATOR : FRANCIS TAY LOCATION : KERTEH CH26.747
CONE ID : 793TC JOB No. : CP-13 (3.90mL)

COSMIC ACCORD SDN.BHD.



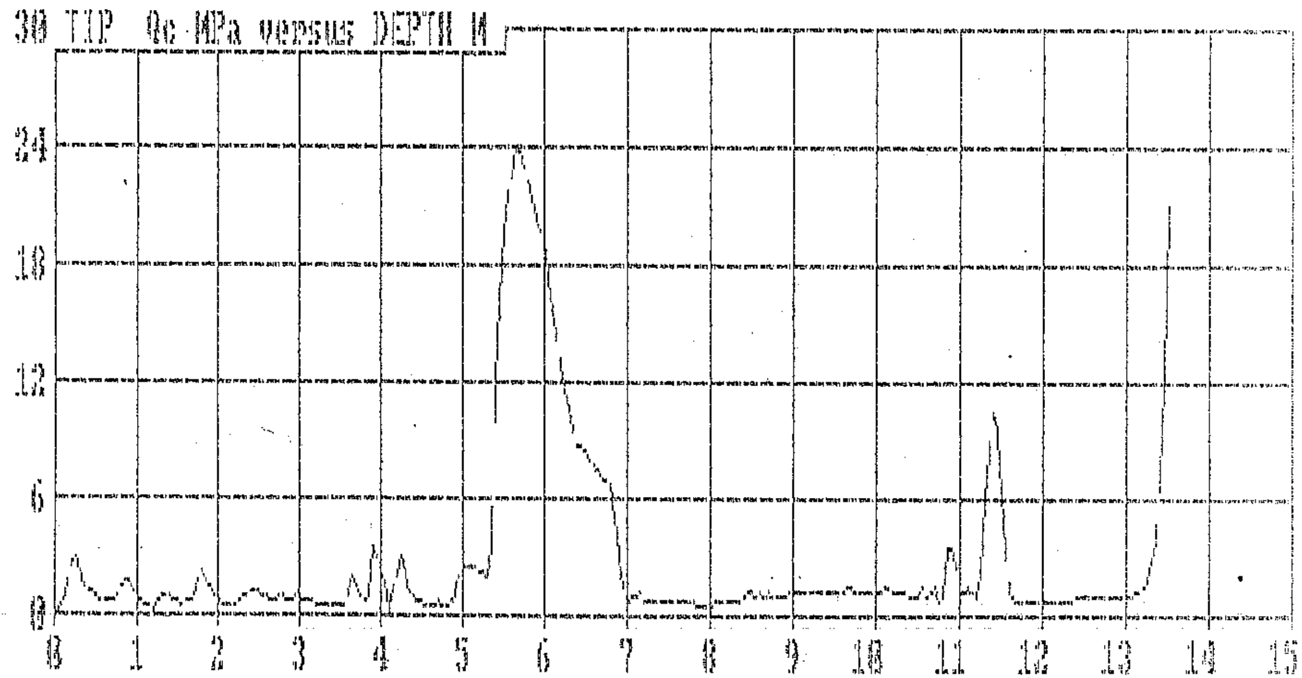
SOUNDING DATA IN FILE CPT166 07-14-05 17:32
OPERATOR : FRANCIS TAY LOCATION : KERTEH CH26.747
CONE ID : 793TC JOB No. : CP-13 (3.90mL)

COSMIC ACCORD SDN.BHD.



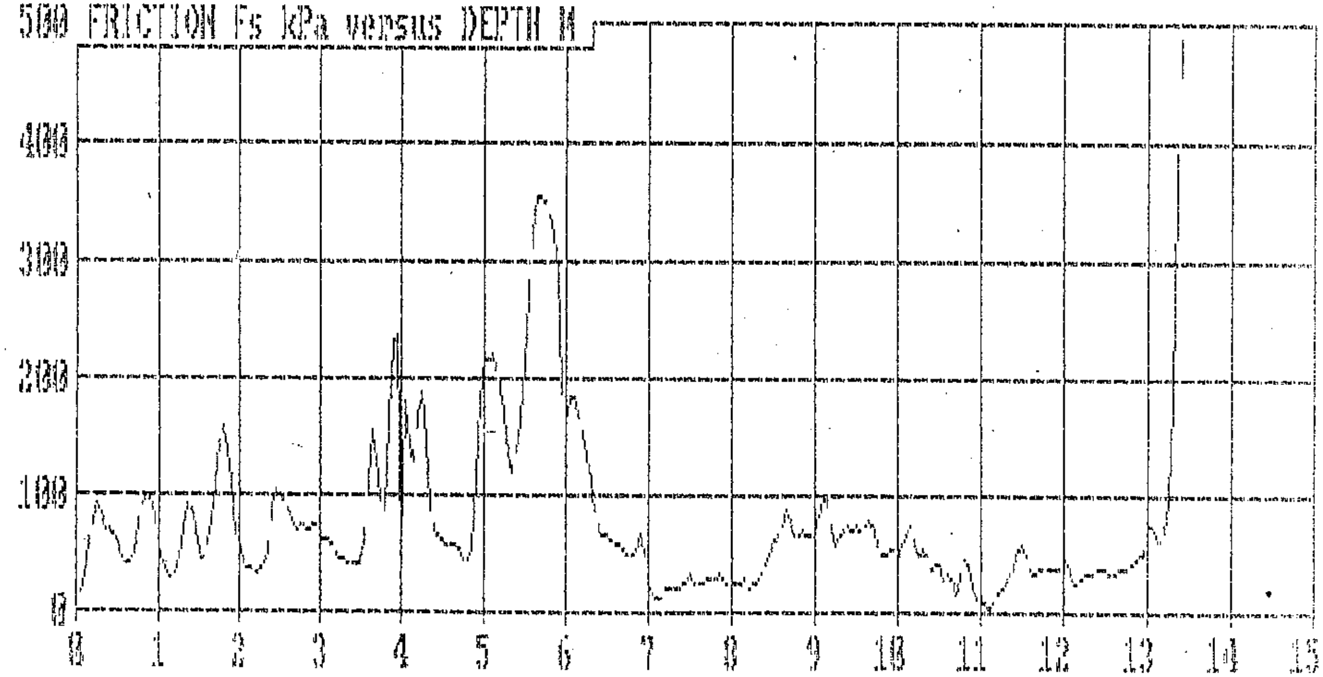
SOUNDING DATA IN FILE CPT166　07-14-05 17:32
OPERATOR : FRANCIS TAY　LOCATION : KERTEH CH26.747
CONE ID : 793TC　JOB No. : CP-13 (3.90mL)

COSMIC ACCORD SDN.BHD.



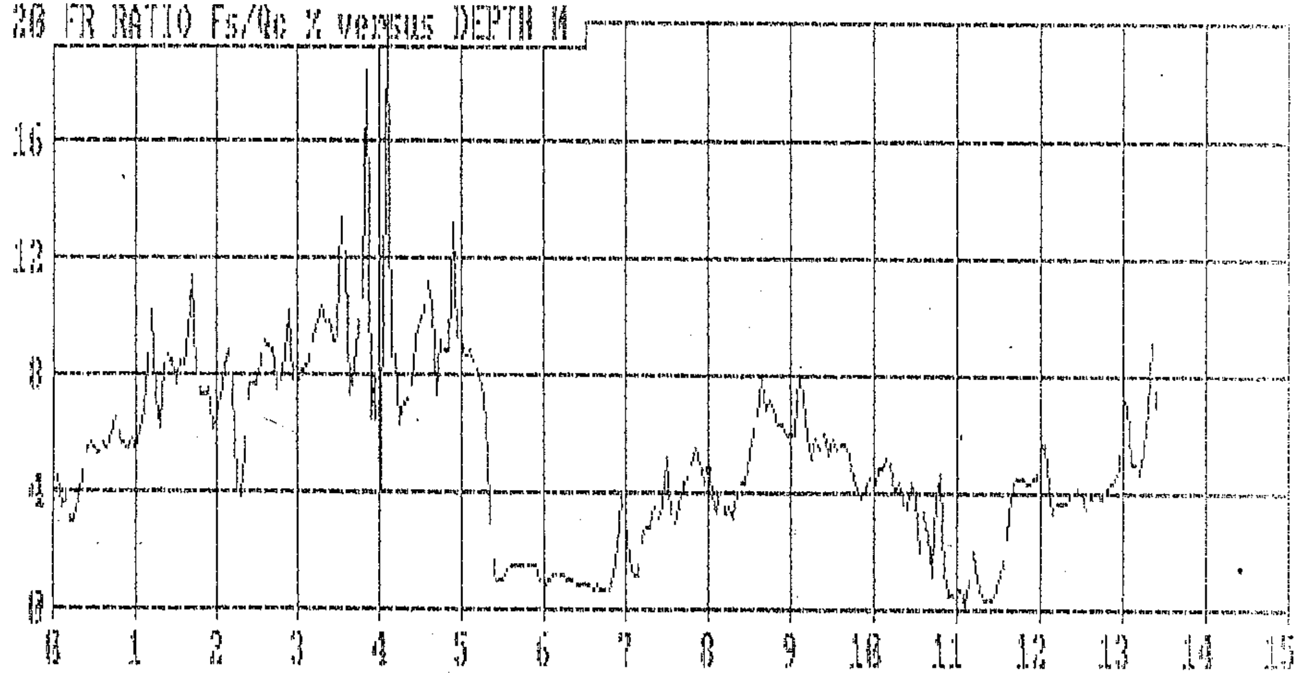
SOUNDING DATA IN FILE CPT166 07-14-05 17:32
OPERATOR : FRANCIS TAY LOCATION : KERTEH CH26.747
CONE ID : 793TC JOB No. : CP-13 (3.90mL)

COSMIC ACCORD SDN.BHD.



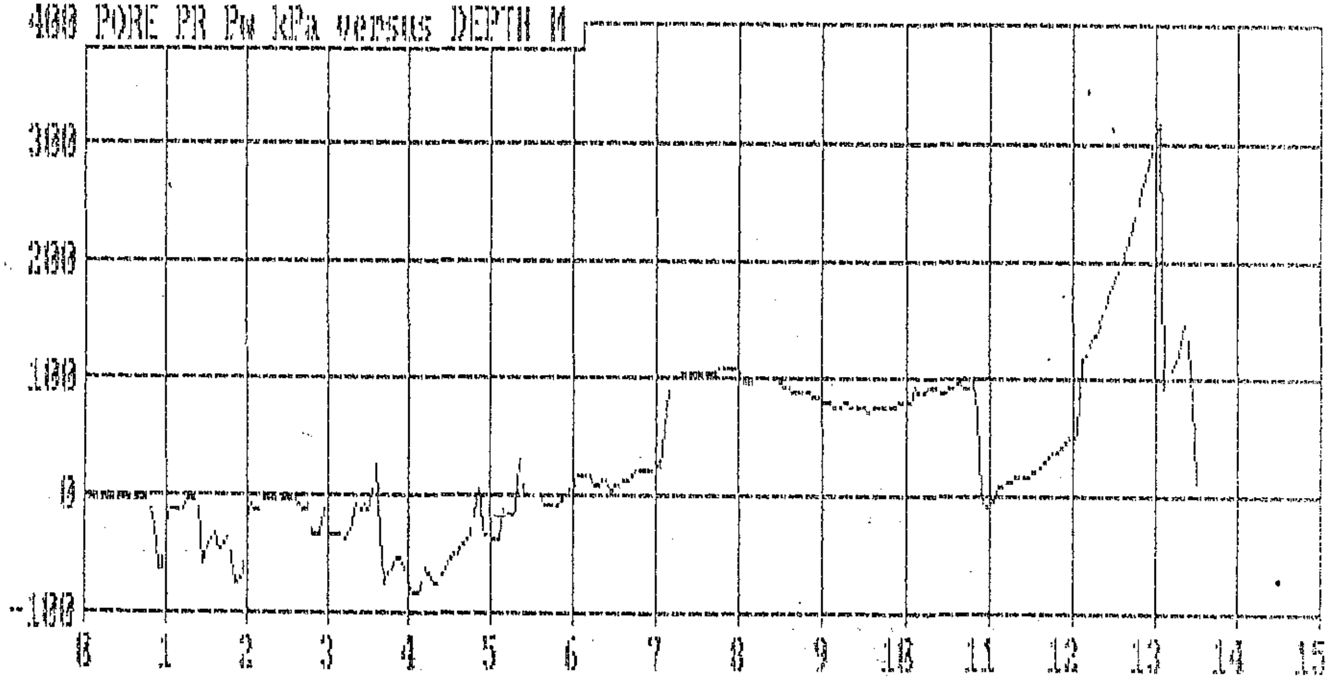
SOUNDING DATA IN FILE CPT166   07-14-05 17:32
OPERATOR : FRANCIS TAY   LOCATION : KERTEH CH26.747
CONE ID : 793TC   JOB No. : CP-13 (3.90mL)

COSMIC ACCORD SDN.BHD.



SOUNDING DATA IN FILE CPT166 07-14-05 17:32
OPERATOR : FRANCIS TAY LOCATION : KERTEH CH26.747
CONE ID : 793TC JOB No. : CP-13 (3.90mL)

COSMIC ACCORD SDN.BHD.



UNDING DATA IN FILE CPT176   07-16-05 16:18

ERATOR : FRANCIS TAY   LOCATION : KERTEH CH26.640

NE ID : 793TC   JOB No. : CP-14 (4.80mR)

3MIC ACCORD SDN.BHD.

?TH ters	TIP Qc MPa	FRICTION Fs kPa	FR RATIO Fs/Qc %	PORE PR Pw kPa	P P RATIO Pw/Qc %	INC I deg	INTERPRETED SOIL TYPE	N SPT
.05	0.30	8.9	3.01	-5	-1.62	0.0	?	?
.10	0.37	7.1	1.90	-3	-0.68	0.0	silty clay to clay	4
.15	0.92	16.7	1.82	-3	-0.33	0.0	clayey silt to silty clay	6
.20	2.09	27.8	1.33	-4	-0.17	0.0	clayey silt to silty clay	7
.25	1.45	27.3	1.88	-3	-0.23	0.0	clayey silt to silty clay	7
.30	0.59	28.1	4.79	-4	-0.60	0.0	clay	8
.35	0.41	23.4	5.66	-3	-0.82	0.0	clay	5
.40	0.42	26.7	6.34	-3	-0.62	0.0	clay	5
.45	0.52	25.0	4.79	-4	-0.68	0.0	clay	5
.50	0.54	21.1	3.89	-4	-0.66	0.0	clay	5
.55	0.42	22.8	5.47	-3	-0.81	0.0	clay	5
.60	0.43	34.9	8.04	-3	-0.78	0.0	clay	5
.65	0.67	45.6	6.76	0	0.01	0.0	clay	6
.70	0.72	43.7	6.09	-13	-1.77	0.0	clay	7
.75	0.60	35.5	5.89	-14	-2.27	0.0	clay	6
.80	0.48	26.2	5.50	-11	-2.36	0.0	clay	5
.85	0.43	37.7	8.86	-11	-2.56	0.0	clay	6
.90	0.81	76.5	9.42	-5	-0.60	0.0	clay	8
.95	1.30	98.6	7.56	-30	-2.29	0.0	clay	11
.00	1.20	79.5	6.60	-50	-4.19	0.0	clay	12
.05	0.97	59.5	6.14	-21	-2.15	0.0	clay	10
.10	0.78	44.1	5.64	-5	-0.60	0.0	clay	8
.15	0.61	33.4	5.44	-5	-0.83	0.0	clay	6
.20	0.45	30.0	6.61	-6	-1.25	0.0	clay	5
.25	0.39	29.2	7.47	-5	-1.36	0.0	clay	4
.30	0.43	28.9	6.74	-4	-1.05	0.0	clay	4
.35	0.47	25.7	5.44	-4	-0.74	0.0	clay	4
.40	0.38	22.7	5.90	-10	-2.63	0.0	clay	4
.45	0.33	22.4	6.80	-10	-3.13	0.0	clay	4
.50	0.36	28.1	8.04	-2	-0.50	0.0	organic material	4
.55	0.42	35.5	8.40	0	0.10	0.0	organic material	4
.60	0.39	34.9	8.85	-10	-2.61	0.0	organic material	4
.65	0.39	33.9	8.64	-2	-0.61	0.0	organic material	4
.70	0.56	47.2	8.46	7	1.17	0.0	clay	6
.75	0.92	62.3	6.76	-12	-1.26	0.0	clay	8
.80	1.04	83.5	8.00	-35	-3.39	0.0	clay	11
.85	1.43	108.5	7.59	-19	-1.35	0.0	clay	15
.90	1.90	115.3	6.07	-48	-2.51	0.0	clay	17
.95	1.92	114.7	5.97	-31	-1.59	0.0	clay	18
.00	1.57	92.3	5.85	-37	-2.32	0.0	clay	16

Average Value

layer 1

Tip = 1.00 MPa.

FR ratio = 7.49

interpretation reference: Robertson & Campanella-1983, based on 60% hammer efficiency and 15 a sliding data average

DEPTH meters	TIP Qc MPa	FRICTION Fs kPa	FR RATIO Fs/Qc %	PORE PR Pw kPa	P P RATIO Pw/Qc %	INC I deg	INTERPRETED SOIL TYPE	N SPT
2.05	1.27	104.6	8.22	-42	-3.27	0.0	clay	13
2.10	1.09	97.0	8.88	-59	-5.37	0.0	clay	12
2.15	1.10	87.3	7.92	-72	-6.52	0.0	clay	10
2.20	0.82	71.3	8.74	-60	-9.79	0.0	clay	8
2.25	0.59	71.3	12.13	-80	-13.62	0.0	clay	8
2.30	0.86	68.8	8.01	-76	-8.90	0.0	clay	8
2.35	0.87	57.0	6.57	-55	-6.31	0.0	clay	8
2.40	0.60	39.1	6.54	-13	-2.17	0.0	clay	7
2.45	0.49	29.2	5.96	-20	-4.06	0.0	clay	5
2.50	0.37	23.6	6.46	-17	-4.75	0.0	clay	4
2.55	0.43	36.6	8.61	-13	-3.17	0.0	clay	5
2.60	0.85	52.2	6.15	-12	-1.45	0.0	clay	7
2.65	0.84	55.2	6.60	-37	-4.43	0.0	clay	7
2.70	0.54	47.0	8.71	-40	-7.36	0.0	clay	6
2.75	0.52	38.9	7.43	-39	-7.38	0.0	organic material	5
2.80	0.43	41.6	9.78	-26	-6.17	0.0	organic material	5
2.85	0.42	32.8	7.87	-14	-3.28	0.0	organic material	4
2.90	0.38	36.8	9.74	-8	-2.11	0.0	organic material	5
2.95	0.62	44.4	7.13	-0	-0.01	0.0	organic material	5
3.00	0.56	50.9	9.16	-46	-8.37	0.0	clay	6
3.05	0.49	45.9	9.32	-54	-10.97	0.0	organic material	5
3.10	0.49	45.3	9.23	-54	-10.96	0.0	organic material	5
3.15	0.42	43.0	10.36	-42	-10.22	0.0	organic material	5
3.20	0.46	42.1	9.07	-36	-7.63	0.0	clay	5
3.25	0.69	45.0	6.50	-28	-3.99	0.0	clay	6
3.30	0.52	47.8	9.14	-19	-3.69	0.0	clay	6
3.35	0.45	42.3	9.48	-64	-14.39	0.0	organic material	5
3.40	0.38	36.9	9.59	-60	-15.56	0.0	organic material	4
.45	0.34	29.6	8.82	-44	-13.02	0.0	organic material	3
.50	0.27	22.3	8.11	-41	-14.81	0.0	organic material	3
.55	0.26	20.9	8.15	-35	-13.76	0.0	organic material	3
.60	0.25	20.7	8.28	-30	-11.83	0.0	organic material	2
.65	0.23	19.2	8.36	-24	-10.34	0.0	organic material	2
.70	0.22	15.7	7.15	-23	-10.44	0.0	organic material	2
.75	0.25	13.4	5.26	-19	-7.64	0.0	organic material	3
.80	0.28	21.7	7.86	-15	-5.58	0.0	?	7
.85	0.43	74.0	17.15	-15	-3.41	0.0	clay	11
.90	2.44	138.5	5.67	-43	-1.76	0.0	clay	18
.95	2.64	174.2	6.60	-58	-2.19	0.0	clay	26
.00	2.57	165.1	6.42	-62	-2.39	0.0	clay	24
.05	2.03	117.3	5.77	-65	-3.19	0.0	clay	20
.10	1.48	95.5	6.45	-58	-3.89	0.0	clay	15
15	1.11	78.8	7.08	-35	-3.17	0.0	clay	11
20	0.75	63.6	8.47	-34	-4.48	0.0	clay	8
25	0.59	52.3	8.90	-30	-5.12	0.0	organic material	6
30	0.59	60.7	10.25	-16	-2.74	0.0	?	7
35	0.75	109.7	14.53	-7	-0.91	0.0	clay	13
40	2.51	144.9	5.78	12	0.48	0.0	clay	17
45	1.91	154.3	8.11	-44	-2.31	0.0	clay	20
50	1.47	118.9	8.08	-50	-3.39	0.0	clay	15

TH ers	TIP Qc MPa	FRICTION Fs kPa	FR RATIO Fs/Qc %	PORE PR Pw kPa	P P RATIO Pw/Qc %	INC I deg	INTERPRETED SOIL TYPE	N SPT
.55	1.08	94.2	8.75	-50	-4.63	0.0	clay	11
.60	0.87	75.6	8.64	-37	-4.19	0.0	clay	9
.65	0.82	70.7	8.64	-29	-3.50	0.0	clay	8
.70	0.79	72.3	9.16	-27	-3.39	0.0	organic material	8
.75	0.78	95.6	12.23	-25	-3.22	0.0	clay	11
.80	1.62	133.4	8.22	-22	-1.35	0.0	clay	14
.85	1.74	160.7	9.24	-24	-1.40	0.0	clay	17
90	1.66	145.5	8.76	-27	-1.61	0.0	clay	19
.95	2.16	161.3	7.46	-18	-0.81	0.0	clay	21
00	2.51	181.2	7.22	-19	-0.77	0.0	clay	22
05	2.05	153.7	7.50	-21	-1.04	0.0	clay	21
10	1.79	124.5	6.97	-18	-1.02	0.0	clay	18
15	1.59	104.6	6.58	-16	-0.98	0.0	clay	16
20	1.37	82.2	6.01	-15	-1.08	0.0	clay	14
25	1.28	92.2	7.21	-14	-1.10	0.0	clay	14
30	1.56	130.1	8.31	-14	-0.87	0.0	clay	15
35	1.75	160.8	9.17	-15	-0.86	0.0	clay	17
40	1.92	176.6	9.17	-15	-0.78	0.0	clay	19
45	2.09	183.2	8.78	-18	-0.84	0.0	clay	20
50	1.98	159.9	8.06	-18	-0.91	0.0	clay	21
55	2.25	187.8	8.36	-14	-0.62	0.0	clay	23
60	2.76	181.7	6.59	-59	-2.13	0.0	clay	23
65	1.92	161.7	8.41	-58	-3.00	0.0	clay	21
70	1.67	138.3	8.26	-53	-3.17	0.0	clay	17
75	1.50	116.7	7.80	-51	-3.38	0.0	clay	15
80	1.28	102.4	8.02	-44	-3.45	0.0	clay	13
85	1.19	96.5	8.14	-39	-3.39	0.0	clay	12
90	1.22	101.8	8.37	-29	-2.41	0.0	clay	12
95	1.32	99.6	7.52	-27	-2.04	0.0	clay	12
00	1.17	88.2	7.51	-22	-1.91	0.0	clay	14
05	1.76	48.8	2.78	-21	-1.19	0.0	clayey silt to silty clay	9
10	2.29	23.5	1.03	6	0.27	0.0	sandy silt to clayey silt	9
15	2.35	13.1	0.56	11	0.46	0.0	silty sand to sandy silt	8
20	2.58	16.7	0.65	11	0.43	0.0	silty sand to sandy silt	9
25	2.90	15.5	0.54	11	0.39	0.0	silty sand to sandy silt	9
30	2.82	16.5	0.59	12	0.43	0.0	silty sand to sandy silt	10
35	3.16	17.6	0.56	12	0.39	0.0	silty sand to sandy silt	11
40	3.71	20.5	0.55	12	0.33	0.0	silty sand to sandy silt	12
45	3.62	32.7	0.85	13	0.34	0.0	silty sand to sandy silt	12
50	2.97	32.2	1.09	13	0.44	0.0	silty sand to sandy silt	11
55	2.75	25.2	0.92	14	0.52	0.0	silty sand to sandy silt	11
60	3.75	21.3	0.58	15	0.39	0.0	silty sand to sandy silt	12
65	3.87	22.3	0.58	16	0.40	0.0	silty sand to sandy silt	13
70	4.08	24.2	0.59	23	0.57	0.0	silty sand to sandy silt	14
75	4.32	25.2	0.58	23	0.54	0.0	silty sand to sandy silt	14
80	4.51	22.7	0.50	23	0.52	0.0	sand to silty sand	12
85	5.05	22.9	0.45	24	0.47	0.0	sand to silty sand	12
90	5.26	21.0	0.40	24	0.46	0.0	sand to silty sand	13
95	4.97	20.8	0.42	24	0.49	0.0	sand to silty sand	12
00	4.51	21.1	0.47	25	0.56	0.0	sand to silty sand	11

Layer 2.
Tip = 3.24 MPa
FR ratio = 0.69

Layer 3
Tip = 4.70 MPa.
FR ratio = 0.42

DEPTH meters	TIP Qc MPa	FRICTION Fs kPa	FR RATIO Fs/Qc %	PORE PR Pw kPa	P P RATIO Pw/Qc %	INC I deg	INTERPRETED SOIL TYPE	N SPT
7.05	3.91	11.7	0.30	26	0.66	0.0	sand to silty sand	10
7.10	3.62	11.7	0.32	27	0.74	0.0	silty sand to sandy silt	12
7.15	3.05	10.5	0.34	26	0.86	0.0	silty sand to sandy silt	11
7.20	3.07	10.3	0.34	27	0.88	0.0	silty sand to sandy silt	10
7.25	3.09	9.8	0.32	28	0.90	0.0	silty sand to sandy silt	10
7.30	3.12	8.0	0.25	28	0.89	0.0	silty sand to sandy silt	10
7.35	2.77	7.8	0.28	28	1.00	0.0	silty sand to sandy silt	9
7.40	2.44	9.0	0.37	28	1.16	0.0	silty sand to sandy silt	9
7.45	2.47	5.1	0.21	29	1.17	0.0	silty sand to sandy silt	8
7.50	2.64	5.2	0.20	30	1.12	0.0	silty sand to sandy silt	8
7.55	2.35	9.5	0.41	30	1.27	0.0	silty sand to sandy silt	8
7.60	2.08	10.3	0.49	30	1.45	0.0	silty sand to sandy silt	7
7.65	1.94	6.4	0.33	31	1.62	0.0	silty sand to sandy silt	7
7.70	2.64	6.2	0.23	32	1.22	0.0	silty sand to sandy silt	8
7.75	2.73	7.3	0.27	32	1.18	0.0	silty sand to sandy silt	9
7.80	2.56	10.5	0.41	34	1.31	0.0	silty sand to sandy silt	8
7.85	2.17	9.5	0.43	34	1.57	0.0	silty sand to sandy silt	8
7.90	2.44	7.1	0.29	35	1.42	0.0	silty sand to sandy silt	8
7.95	2.61	7.7	0.29	35	1.35	0.0	silty sand to sandy silt	9
8.00	2.70	8.8	0.33	36	1.33	0.0	silty sand to sandy silt	9
8.05	2.70	8.8	0.33	37	1.36	0.0	silty sand to sandy silt	9
8.10	2.67	10.1	0.38	37	1.39	0.0	silty sand to sandy silt	9
8.15	2.53	20.9	0.83	37	1.47	0.0	silty sand to sandy silt	8
8.20	1.99	16.6	0.84	38	1.90	0.0	silty sand to sandy silt	8
8.25	2.59	12.6	0.49	41	1.57	0.0	silty sand to sandy silt	9
8.30	3.37	10.9	0.32	37	1.10	0.0	silty sand to sandy silt	11
8.35	3.70	9.9	0.27	37	1.00	0.0	silty sand to sandy silt	12
8.40	3.76	11.2	0.30	38	1.01	0.0	sand to silty sand	9
8.45	3.55	12.0	0.34	38	1.07	0.0	silty sand to sandy silt	12
8.50	3.68	12.0	0.33	38	1.03	0.0	silty sand to sandy silt	12
8.55	3.64	12.6	0.35	39	1.06	0.0	silty sand to sandy silt	12
8.60	3.52	13.5	0.38	39	1.11	0.0	silty sand to sandy silt	12
8.65	3.66	12.7	0.35	39	1.07	0.0	silty sand to sandy silt	12
8.70	3.90	12.4	0.32	39	1.01	0.0	sand to silty sand	10
8.75	4.08	12.7	0.31	40	0.99	0.0	sand to silty sand	10
8.80	4.24	11.3	0.27	41	0.96	0.0	sand to silty sand	11
8.85	4.33	12.7	0.29	41	0.95	0.0	sand to silty sand	11
8.90	4.35	17.9	0.41	42	0.97	0.0	sand to silty sand	11
8.95	4.14	18.0	0.43	44	1.05	0.0	sand to silty sand	11
9.00	4.28	16.8	0.39	44	1.04	0.0	sand to silty sand	11
9.05	4.43	14.8	0.33	45	1.02	0.0	sand to silty sand	11
9.10	4.54	13.7	0.30	46	1.01	0.0	sand to silty sand	11
9.15	4.52	17.1	0.38	45	0.99	0.0	sand to silty sand	11
9.20	4.49	19.6	0.44	45	1.01	0.0	sand to silty sand	11
9.25	4.67	20.9	0.45	46	0.98	0.0	sand to silty sand	12
9.30	4.92	28.6	0.58	46	0.93	0.0	sand to silty sand	12
9.35	5.22	47.4	0.91	46	0.89	0.0	silty sand to sandy silt	17
9.40	5.06	78.8	1.56	47	0.93	0.0	silty sand to sandy silt	16
9.45	3.31	79.8	2.41	47	1.42	0.0	sandy silt to clayey silt	14
9.50	1.92	68.5	3.56	48	2.52	0.0	clayey silt to silty clay	12

Layer 4
Tip = 2.87 MPa.
FR ratio = 0.36

Layer 5
Tip = 4.38 MPa
FR ratio = 0.38

Layer 6
Tip = 1.90 MPa
FR ratio = 2.93

TH ers	TIP Qc MPa	FRICTION Fs kPa	FR RATIO Fs/Qc %	PORE PR Pw kPa	P P RATIO Pw/Qc %	INC I deg	INTERPRETED SOIL TYPE	N SPT
.55	1.53	42.9	2.80	50	3.26	0.0	clayey silt to silty clay	8
.60	1.25	39.4	3.15	54	4.29	0.0	silty clay to clay	8
.65	1.01	40.8	4.03	56	5.52	0.0	silty clay to clay	7
.70	1.04	38.0	3.64	58	5.56	0.0	silty clay to clay	8
.75	1.40	38.8	2.76	58	4.12	0.0	silty clay to clay	9
.80	1.46	49.9	3.42	59	4.05	0.0	silty clay to clay	10
.85	1.65	71.5	4.33	60	3.61	0.0	silty clay to clay	12
.90	2.49	112.4	4.52	61	2.46	0.0	silty clay to clay	16
.95	3.25	127.5	3.92	61	1.87	0.0	clay	27
.00	2.41	134.6	5.58	57	2.37	0.0	silty clay to clay	20
.05	3.19	138.5	4.34	59	1.86	0.0	clayey silt to silty clay	15
.10	3.42	23.0	0.67	58	1.70	0.0	sandy silt to clayey silt	14
.15	3.67	131.7	3.59	54	1.48	0.0	clayey silt to silty clay	14
.20	1.53	119.8	7.81	54	3.52	0.0	clay	24
.25	2.11	83.8	3.97	52	2.48	0.0	clay	17
.30	1.38	39.6	2.88	56	4.08	0.0	clayey silt to silty clay	8
.35	1.55	17.4	1.12	57	3.68	0.0	clayey silt to silty clay	6
.40	0.93	16.4	1.77	59	6.31	0.0	clayey silt to silty clay	6
.45	0.90	20.5	2.28	59	6.59	0.0	clayey silt to silty clay	5
.50	0.95	15.4	1.62	60	6.35	0.0	clayey silt to silty clay	5
.55	1.31	13.1	1.00	61	4.62	0.0	clayey silt to silty clay	6
.60	1.28	15.3	1.19	61	4.79	0.0	clayey silt to silty clay	6
.65	1.00	17.8	1.77	62	6.18	0.0	clayey silt to silty clay	5
.70	0.92	25.6	2.79	63	6.83	0.0	clayey silt to silty clay	5
.75	0.96	21.6	2.26	64	6.66	0.0	silty clay to clay	6
.80	1.01	26.8	2.65	64	6.31	0.0	clayey silt to silty clay	5
.85	1.01	16.8	1.66	65	6.40	0.0	clayey silt to silty clay	5
.90	1.07	21.9	2.04	65	6.04	0.0	silty clay to clay	7
.95	0.88	47.5	5.39	66	7.46	0.0	clayey silt to silty clay	6
.00	1.94	41.3	2.13	67	3.46	0.0	clayey silt to silty clay	8
.05	2.09	25.3	1.21	32	1.54	0.0	sandy silt to clayey silt	7
.10	1.28	11.7	0.91	22	1.74	0.0	sandy silt to clayey silt	6
.15	1.14	17.2	1.50	24	2.09	0.0	clayey silt to silty clay	5
.20	0.78	18.5	2.37	25	3.23	0.0	clayey silt to silty clay	6
.25	1.82	13.4	0.74	45	2.48	0.0	sandy silt to clayey silt	6
.30	1.66	22.1	1.35	45	2.69	0.0	sandy silt to clayey silt	6
.35	1.11	15.0	1.35	46	4.12	0.0	sandy silt to clayey silt	6
.40	1.77	11.3	0.64	47	2.68	0.0	sandy silt to clayey silt	7
.45	2.09	17.3	0.85	48	2.29	0.0	silty sand to sandy silt	8
.50	3.10	17.2	0.56	49	1.58	0.0	silty sand to sandy silt	10
.55	4.08	14.5	0.35	50	1.23	0.0	silty sand to sandy silt	12
.60	3.93	17.3	0.44	51	1.29	0.0	silty sand to sandy silt	12
.65	2.86	18.3	0.62	49	1.67	0.0	silty sand to sandy silt	11
.70	2.65	9.4	0.35	50	1.89	0.0	silty sand to sandy silt	9
.75	2.79	8.1	0.29	44	1.57	0.0	silty sand to sandy silt	9
.80	2.57	9.1	0.36	44	1.73	0.0	silty sand to sandy silt	10
.85	3.21	13.0	0.40	46	1.42	0.0	silty sand to sandy silt	10
.90	3.57	13.9	0.39	48	1.33	0.0	silty sand to sandy silt	12
.95	4.15	14.5	0.35	49	1.18	0.0	sand to silty sand	11
.00	5.18	17.9	0.35	50	0.97	0.0	sand to silty sand	12

Layer 7
Tip = 2.68 MPa
FR ratio = 0.80

PTH ters	TIP Qc MPa	FRICTION Fs kPa	FR RATIO Fs/Qc %	PORE PR Pw kPa	P P RATIO Pw/Qc %	INC I deg	INTERPRETED SOIL TYPE	N SPT
2.05	5.16	23.5	0.46	52	1.01	0.0	silty sand to sandy silt	15
2.10	3.10	34.0	1.10	54	1.73	0.0	silty sand to sandy silt	11
2.15	1.40	20.6	1.47	57	4.07	0.0	sandy silt to clayey silt	7
2.20	0.96	17.3	1.80	91	9.51	0.0	clayey silt to silty clay	5
2.25	0.74	19.1	2.57	100	13.37	0.0	silty clay to clay	5
2.30	0.73	34.9	4.75	108	14.67	0.0	clay	8
2.35	0.88	32.7	3.71	114	12.94	0.0	clay	9
2.40	0.94	30.6	3.24	115	12.17	0.0	clay	9
2.45	0.77	24.5	3.17	121	15.69	0.0	silty clay to clay	5
2.50	0.76	22.2	2.93	129	17.01	0.0	clay	8
2.55	0.77	23.9	3.11	137	17.87	0.0	clay	8
2.60	0.75	29.0	3.84	146	19.30	0.0	clay	9
2.65	0.81	32.0	3.94	154	18.87	0.0	clay	8
2.70	0.87	28.0	3.21	163	18.67	0.0	clay	8
.75	0.85	27.3	3.21	174	20.44	0.0	silty clay to clay	6
.80	1.01	29.7	2.94	185	18.31	0.0	silty clay to clay	7
.85	1.16	30.2	2.60	198	16.98	0.0	silty clay to clay	7
.90	1.18	35.7	3.02	208	17.63	0.0	silty clay to clay	8
.95	1.08	40.2	3.73	225	20.89	0.0	silty clay to clay	8
.00	1.49	50.7	3.39	242	16.22	0.0	silty clay to clay	10
.05	1.89	67.1	3.54	256	13.50	0.0	silty clay to clay	12
.10	2.09	94.0	4.50	275	13.16	0.0	clay	22
.15	2.65	177.2	6.69	291	10.96	0.0	clay	27
.20	3.22	229.9	7.15	311	9.68	0.0	clay	37
.25	5.36	206.5	3.85	174	3.25	0.0	clayey silt to silty clay	27
.30	7.76	185.0	2.39	91	1.17	0.0	sandy silt to clayey silt	31
.35	10.10	227.0	2.25	-0	-0.00	0.0	silty sand to sandy silt	32
.40	10.74	217.9	2.03	-37	-0.34	0.0	silty sand to sandy silt	36
.45	11.70	193.0	1.65	-63	-0.54	0.0	silty sand to sandy silt	39
.50	12.27	256.4	2.09	-63	-0.51	0.0	?	?
.55	15.53	?	?	-67	-0.43	0.0	?	?
.60	18.01	?	?	-61	-0.34	0.0	?	?

Layer 8

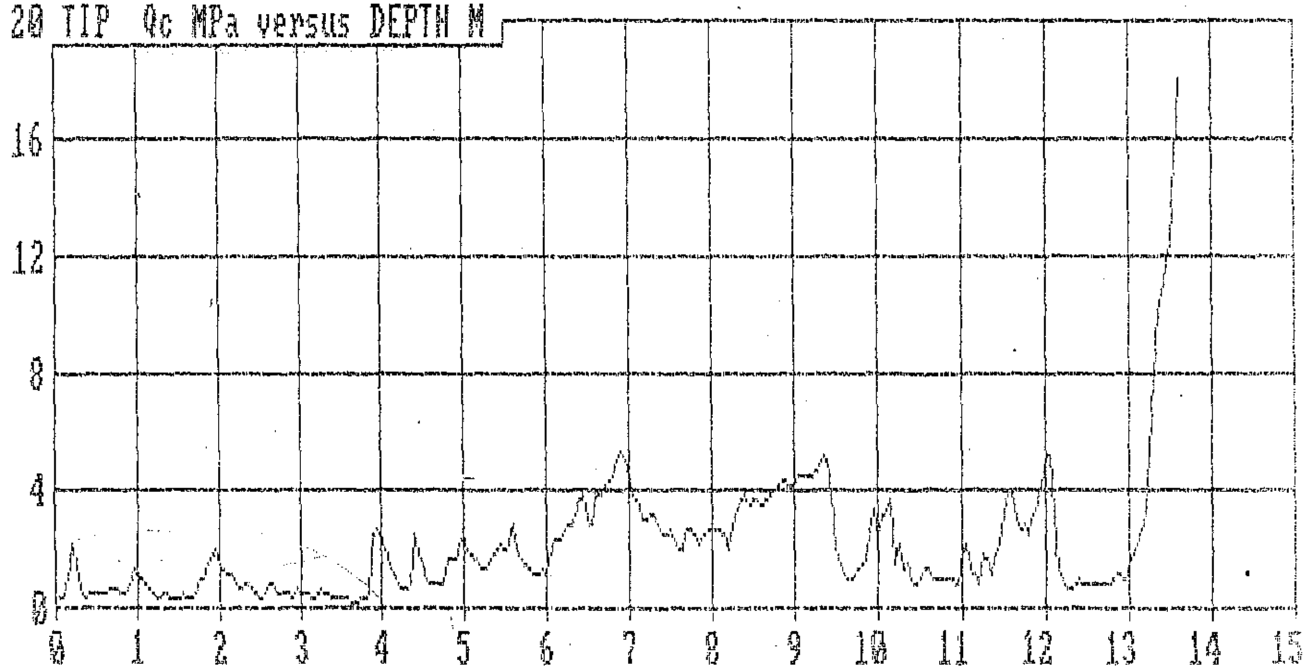
Tip = 3.09 MPa

FR ratio = 3.38

Interpretation reference: Robertson & Campanella-1983, based on 60% hammer efficiency and .15 m sliding data average

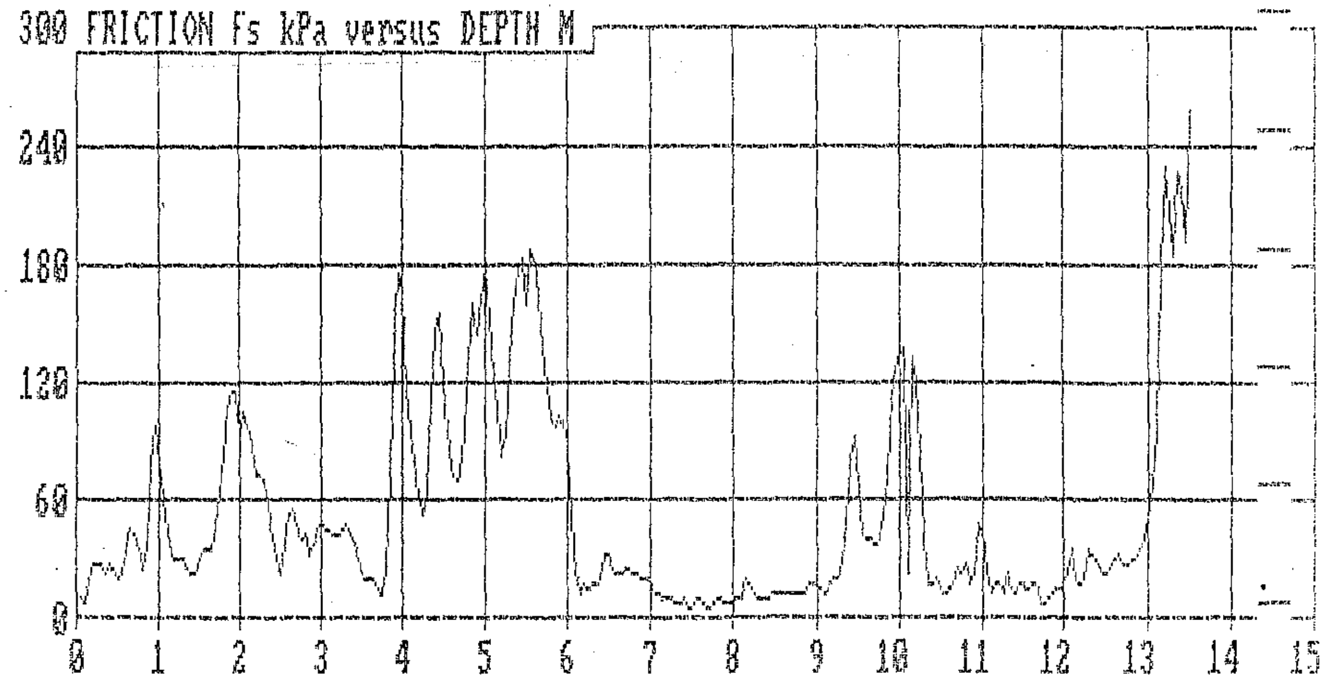
SOUNDING DATA IN FILE CPT176 07-16-05 16:18
OPERATOR : FRANCIS TAY LOCATION : KERTEH CH26.640
CONE ID : 793TC JOB No. : CP-14 (4.80mR)

COSMIC ACCORD SDN.BHD.



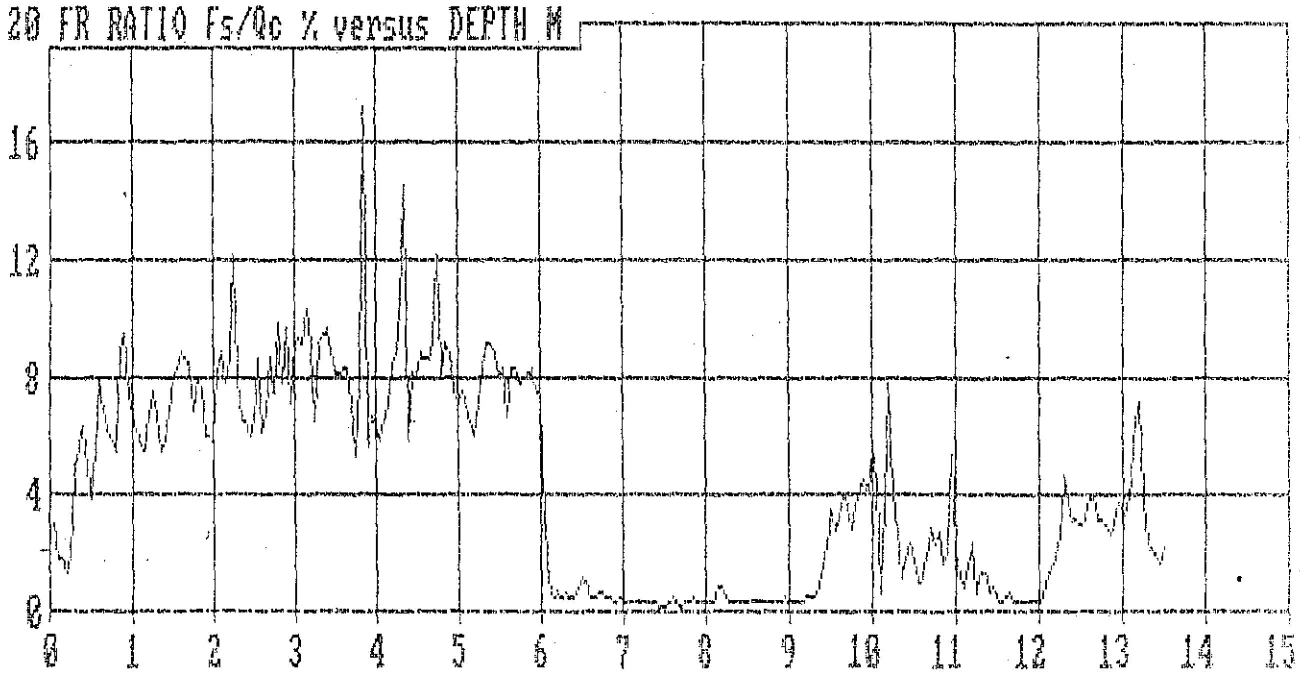
SOUNDING DATA IN FILE CPT176 07-16-05 16:18
OPERATOR : FRANCIS TAY LOCATION : KERTEH CH26.640
CONE ID : 793TC JOB No. : CP-14 (4.80mR)

COSMIC ACCORD SDN.BHD.



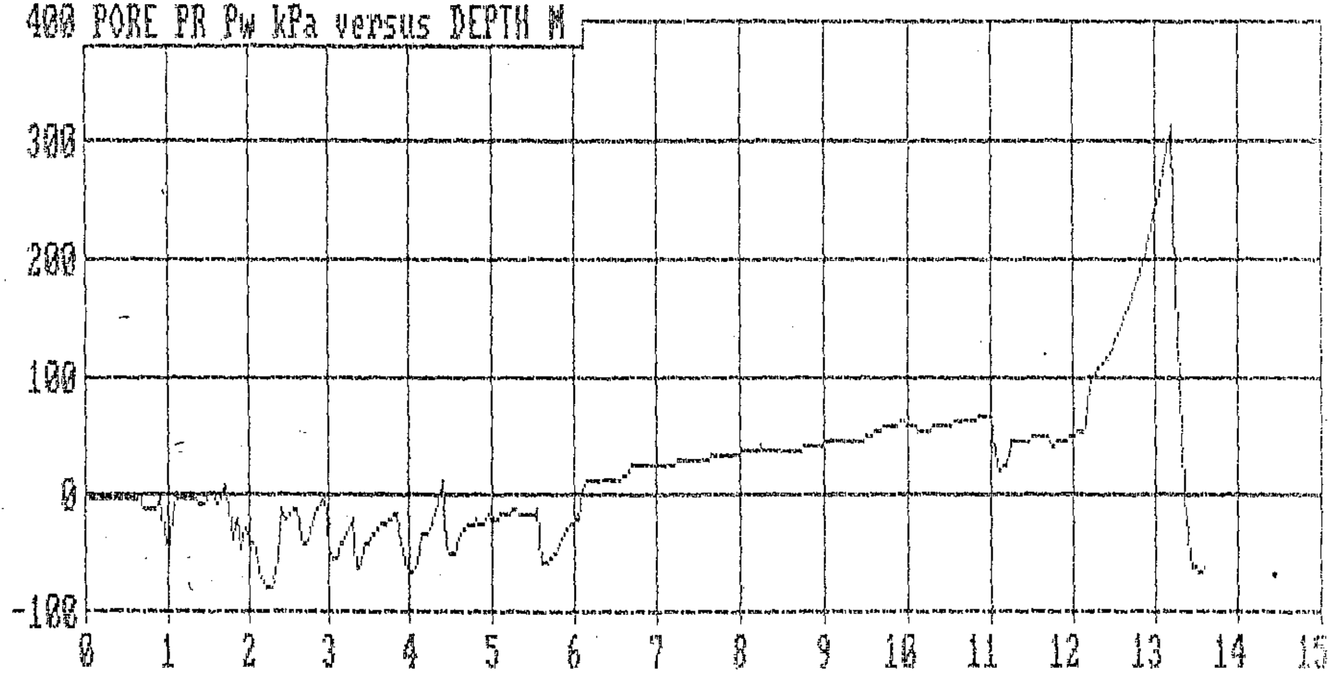
SOUNDING DATA IN FILE CPT176 07-16-05 16:18
OPERATOR : FRANCIS TAY LOCATION : KERTEH CH26.640
CONE ID : 793TC JOB No. : CP-14 (4.00mR)

COSMIC ACCORD SDN.BHD.



SOUNDING DATA IN FILE CPT176   07-16-05 16:18
OPERATOR : FRANCIS TAY   LOCATION : KERTEH CH26.640
CONE ID : 793TC   JOB No. : CP-14 (4.80mR)

COSMIC ACCORD SDN.BHD.



CLIENT/ENGINEER	:	COSMIC ACCORD S/B	BOREHOLE NO	:	BH 1
PROJECT	:	Cerun Runtuh Di Projek KKRS Kerteh	GROUND LEVEL	:	
	:	- CH. 26325 - CH 27000	DATE STARTED	:	4/6/2005
LOCATION	:	- CH. 26600	DATE COMPLETED	:	7/6/2005
TYPE OF BORING	:	ROTARY WASH	FINAL WATER LEVEL	:	2.80 m. - 12/6/2005

DEPTH BELOW GROUND SURFACE	SAMPLE NO.	SPT 152mm CORING RUN	SPT 152mm CORE RECOVERY	SPT 152mm RATIO	THICKNESS OF LAYERS	LEGEND	DESCRIPTION	TIME	GROUND WATER LEVEL	CASING TYPE	CASING DEPTH	REMARKS DATE
metre		m.	m.	%	metre			hr. min.	m.		m	
0.00	D1	TOP SOIL					Yellowish brown sandy clayey SILT with fine gravel and root.					
1.50	P1/D2	1/0	0/1	1/1			Soft. Yellowish brown sandy clayey SILT with a little of fine gravel.					
			N = 3									
1.95			R/r = 340/450									
	UD1		R/r = Nil				- No sample -					
2.45												
3.00	P2/D3	1/0	0/0	1/0			Very soft. Yellowish brown sandy clayey SILT with a little of fine gravel.					
3.45			N = 1									
			R/r = 380/450									
3.95	UD2		R/r = 300/500				Very soft. Yellowish brown sandy clayey SILT with a little of fine gravel.					
4.50	P3/D4	1/1	1/2	2/4			Stiff. Reddish brown sandy clayey SILT with a little of fine gravel.					
			N = 9									
4.95			R/r = 380/450									
6.00	P4/D5	1/3	2/2	3/2			Loose. Light grey coarse to fine silty SAND with a little of fine gravel.	1630	1.42	NW	6.0	04/0[illegible]
6.45			N = 3					0830	2.64	NW	6.0	05/0[illegible]
			R/r = 310/450									
7.50	P5/D6	2/3	3/3	3/2			Loose. Light grey coarse to fine silty SAND with a little of fine gravel.					
			N = 11									
7.95			R/r = 290/450									
9.00	P6/D7	1/0	0/1	0/1			Very loose. Light grey coarse to fine silty SAND with decayed wood.					
9.45			N = 2									
			R/r = 210/450									

DISTURBED (D)	UNDISTURBED (UD)	OPERATOR : SYED BAKRI	SCALE :
SPT (P)	CORING (C)	SUPERVISOR : M. KHAIRI	CHECKED : ABD. RASHID

GEOLAB BINA ENTERPRISE CA 0060024-X

ꟷA ENTERPRISE

FIELD BORE LOG

ꟷER	:	COSMIC ACCORD S/B	BOREHOLE NO	:	BH 1
	:	Cerun Runtuh Di Projek KKRS Kerteh	GROUND LEVEL	:	
	:	- CH. 26325 - CH 27000	DATE STARTED	:	4/6/2005
	:	- CH. 26600	DATE COMPLETED	:	7/6/2005
ꟷING	:	Rotary Wash	FINAL WATER LEVEL	:	2.80 m. - 12/6/2005

ꟷPLE ꟷ).	SPT 152mm CORING RUN	152mm CORE RECOVERY	152mm RATIO	THICKNESS OF LAYERS	LEGEND	DESCRIPTION	TIME	GROUND WATER LEVEL	CASING TYPE	CASING DEPTH	REMARKS DATE
	m.	m.	%	metre			hr. min.	m.		m	
							1800	0.92	-	-	07/06/05
						End of borehole at 20.0 m.	0930	0.96	-	-	08/06/05
							1300	1.00	-	-	08/06/05
							0900	1.12	-	-	09/06/05
							1700	1.24	-	-	09/06/05
							0900	1.30	-	-	10/06/05
							1700	1.44	-	-	10/06/05
							0900	1.58	-	-	11/06/05
							1700	2.02	-	-	11/06/05
							0900	2.80	-	-	12/06/05

DISTURBED (D)	☒ UNDISTURBED (UD)	OPERATOR : SYED BAKRI	SCALE :
SPT (P)	CORING (C)	SUPERVISOR: M. KHAIRI	CHECKED : ABD. BASHID

GEOLAB BINA ENTERPRISE

FIELD BORE LOG

CLIENT/ENGINEER	: COSMIC ACCORD S/B		BOREHOLE NO	:	BH 2
PROJECT	: Cerun Runtuh Di Projek KKRS Kerteh		GROUND LEVEL	:	
	: - CH. 26325 - CH 27000		DATE STARTED	:	9/6/2005
LOCATION	: - CH. 26750		DATE COMPLETED	:	11/6/2005
TYPE OF BORING	: ROTARY WASH		FINAL WATER LEVEL	:	4.42 m. - 12/6/2005

DEPTH BELOW GROUND SURFACE (metre)	SAMPLE NO.	SPT 152mm / CORING RUN (m.)	SPT 152mm / CORE RECOVERY (m.)	SPT 152mm / RATIO (%)	THICKNESS OF LAYERS (metre)	LEGEND	DESCRIPTION	TIME (hr. min.)	GROUND WATER LEVEL (m.)	CASING TYPE	CASING DEPTH (m)	REMARKS DATE
0.00	D1		TOP SOIL				Reddish brown sandy clayey SILT with a little of fine gravel and root.					
1.50 – 1.95	P1/D2	1/0	1/1 N = 6 R/r = 340/450	2/2			Medium stiff.Yellowish brown sandy clayey SILT with traces of fine gravel.					
1.95 – 2.45	UD1		R/r = Nil				- No sample -					
3.00 – 3.45	P2/D3	1/1	2/1 N = 7 R/r = 310/450	2/2			Medium stiff.Yellowish brown sandy clayey SILT with traces of fine gravel.					
3.45 – 3.95	UD2		R/r = 250/500				Medium stiff.Yellowish brown sandy clayey SILT with a little of fine gravel.					
4.50 – 4.95	P3/D4	1/0	2/3 N = 9 R/r = 420/450	2/2			Stiff. Yellowish brown sandy clayey SILT with a little of fine gravel.					
6.00 – 6.45	P4/D5	4/6	6/5 N = 22 R/r = 320/450	5/6			Medium dense. Grey coarse to fine silty SAND with a little of fine gravel.					
7.50 – 7.95	P5/D6	3/4	4/5 N = 19 R/r = 320/450	5/5			Medium dense. Grey coarse to fine silty SAND with a little of fine gravel.					
9.00 – 9.45	P6/D7	0/1	1/2 N = 7 R/r = 260/450	2/2			Medium stiff. Grey sandy clayey SILT.					
	UD3		R/r = 400/500				Medium stiff. Grey sandy clayey SILT.					

DISTURBED (D)	UNDISTURBED (UD)	OPERATOR : SYED BAKRI	SCALE :
SPT (P)	CORING (C)	SUPERVISOR : M. KHAIRI	CHECKED : ABD. RASHID

GEOLAB BINA ENTERPRISE CA 0060024-X

CLIENT/ENGINEER	:	COSMIC ACCORD S/B	BOREHOLE NO	:	BH 2
PROJECT	:	Cerun Runtuh Di Projek KKRS Kerteh	GROUND LEVEL	:	
	:	- CH. 26325 - CH 27000	DATE STARTED	:	9/6/2005
LOCATION	:	- CH. 26750	DATE COMPLETED	:	11/6/2005
TYPE OF BORING	:	ROTARY WASH	FINAL WATER LEVEL	:	4.42 m. - 12/6/2005

DEPTH BELOW GROUND SURFACE (metre)	SAMPLE NO.	SPT 152mm CORING RUN (m.)	SPT 152mm CORE RECOVERY (m.)	SPT 152mm RATIO (%)	THICKNESS OF LAYERS (metre)	LEGEND	DESCRIPTION	TIME (hr. min.)	GROUND WATER LEVEL (m.)	CASING TYPE	CASING DEPTH (m)	REMARKS DATE
10.50 – 10.95	P7/D8	1/2	2/3 N = 10 R/r = 220/450	3/2			Stiff. Grey sandy clayey SILT with traces of fine gravel.					
12.00 – 12.45	P8/D9	2/1	2/2 N = 8 R/r = 410/450	2/2			Medium stiff. Light grey sandy clayey SILT.					
	UD4		R/r = 500/500				Medium stiff. Light grey sandy clayey SILT.					
13.50 – 13.95	P9/D10	2/2	2/3 N = 9 R/r = 4000/450	2/2			Stiff. Light grey sandy clayey SILT with traces of fine gravel.					
15.00	P10/ -	50	Hammer rebound N = 50 R/r = Nil				- No sample -	1730	4.23	NW	15.0	10/06
16.00	C1	1.0	0.5 RQD = Nil	50			Grey GRANITE.					
	C2	1.5	1.2 RQD = 10 %	80			Pink spotted black and white GRANITE.					
17.50	C3	1.5	1.5 RQD = 40 %	100			Pink spotted black GRANITE.					
19.00	C4	1.0	1.0 RQD = 40 %	100			Pinkish bluish grey GRANITE.					
20.00												

DISTURBED (D)	UNDISTURBED (UD)	OPERATOR : SYED BAKRI	SCALE:
SPT (P)	CORING (C)	SUPERVISOR : M. KHAIRI	CHECKED : ABD. RASHID

GEOLAB BINA ENTERPRISE CA 0000024-X

GEOLAB BINA ENTERPRISE

FIELD BORE LOG

CLIENT/ENGINEER	:	COSMIC ACCORD S/B	BOREHOLE NO	:	BH 2
PROJECT	:	Cerun Runtuh Di Projek KKRS Kerteh	GROUND LEVEL	:	
	:	- CH. 26325 - CH 27000	DATE STARTED	:	9/6/2005
LOCATION	:	- CH. 26750	DATE COMPLETED	:	116/2005
TYPE OF BORING	:	Rotary Wash	FINAL WATER LEVEL	:	4.42 m. - 12/6/2005

SAMPLE NO.	SPT 152mm CORING RUN	SPT 152mm CORE RECOVERY	SPT 152mm RATIO	THICKNESS OF LAYERS	LEGEND	DESCRIPTION	TIME	GROUND WATER LEVEL	CASING TYPE	CASING DEPTH	REMARKS DATE
	m.	m.	%	metre			hr. min.	m.		m	
							1730	3.98	NW	15.0	11/06/(
						End of borehole at 20.0 m.	1700	Full	-	-	11/06/(
							1900	4.17	-	-	11/06/(
							0900	4.42	-	-	12/06/(

DISTURBED (D) UNDISTURBED (UD) SPT (P) CORING (C)

OPERATOR : SYED BAKRI

SCALE :

SUPERVISOR : M. KHAIRI

CHECKED : ABD. BASHID

GEOLAB BINA ENTERPRISE CA 0060024-X

Appendix C

Project Photos

Photo C-1: Typical Slope Erosion

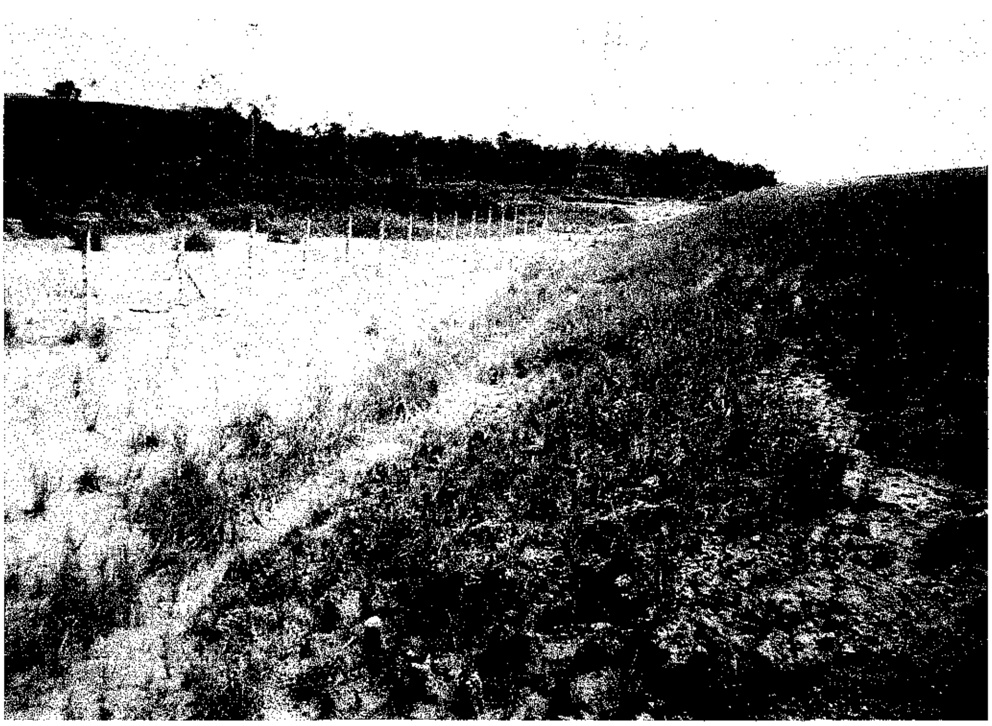


Photo C-2: Typical Slope Erosion

Photo C-3: Separation of The Ballast/Subballast From The Embankment Slope

Photo C-4: Silted Concrete Side Drain on The West Side of The Embankment Between CH26675 - CH26325.

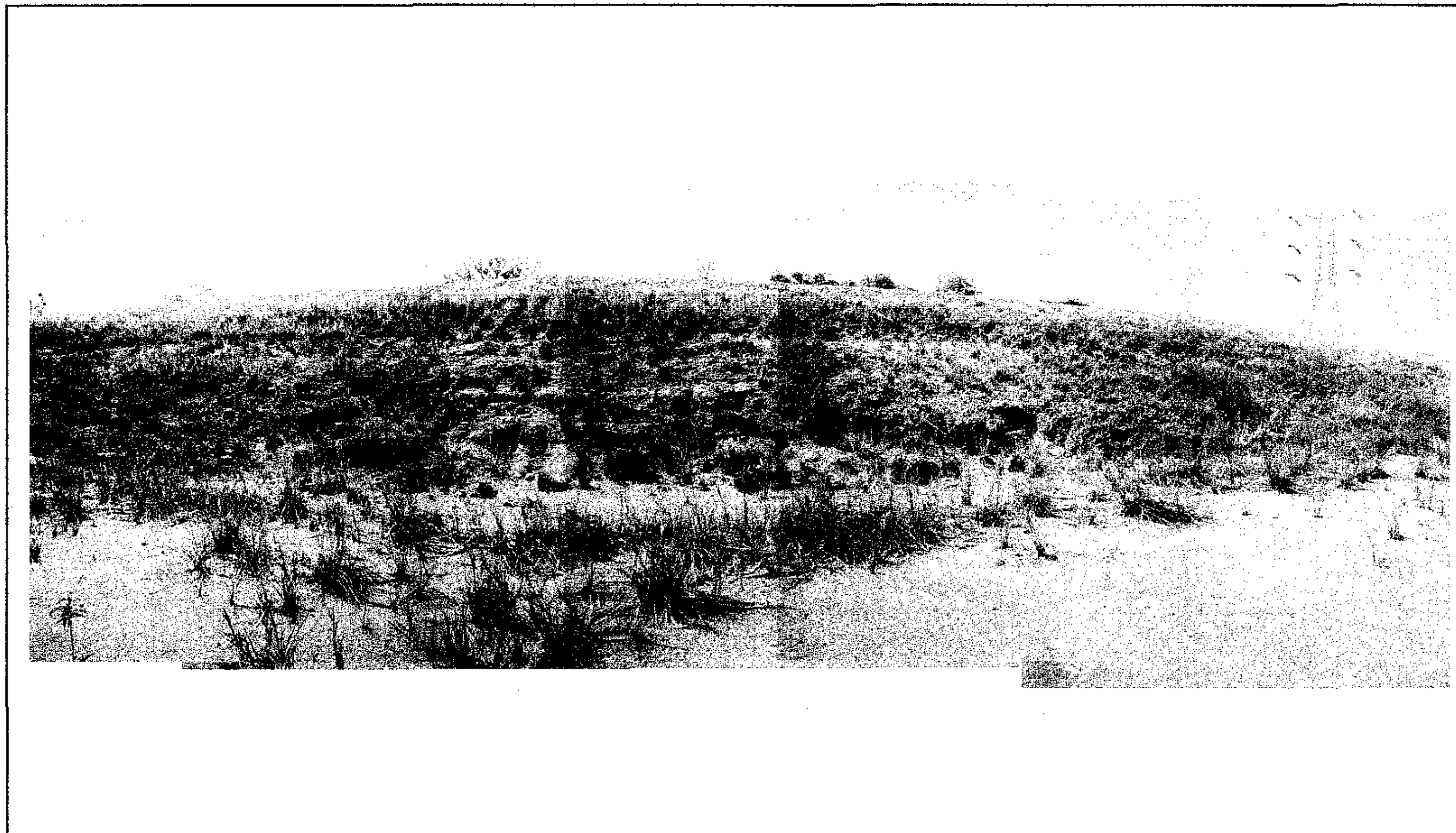


Photo C-5 Erosion at CH 26800 – CH 26850

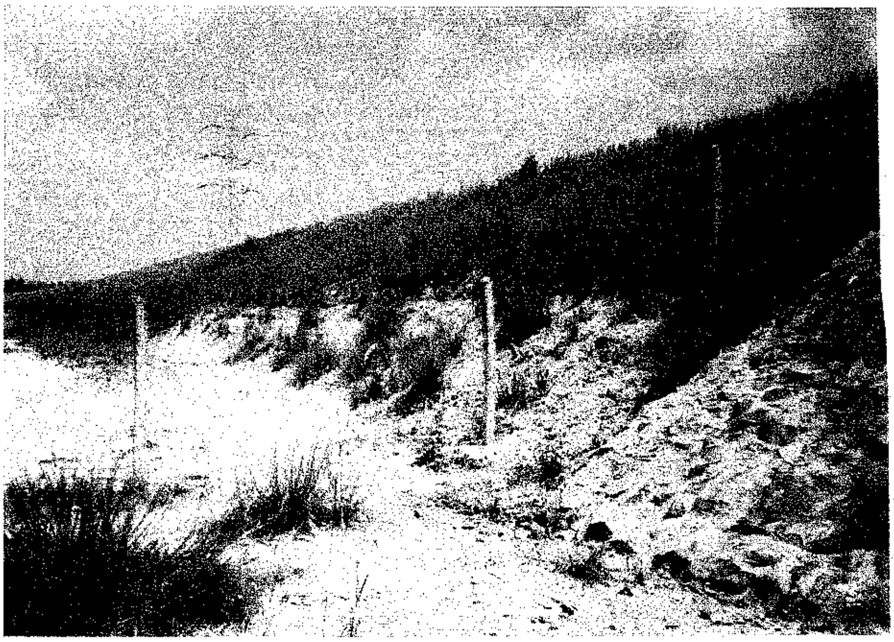


Photo C-6: Erosion of toe at CH 26+325 (East Side)

Photo C-7: Erosion of Abutment Slope at CH 26+325 (West Side)

Photo C-8: Erosion on East Slope of CH 26+975

Photo C-9: Erosion of West Slope at CH 26+800 to CH 26+850

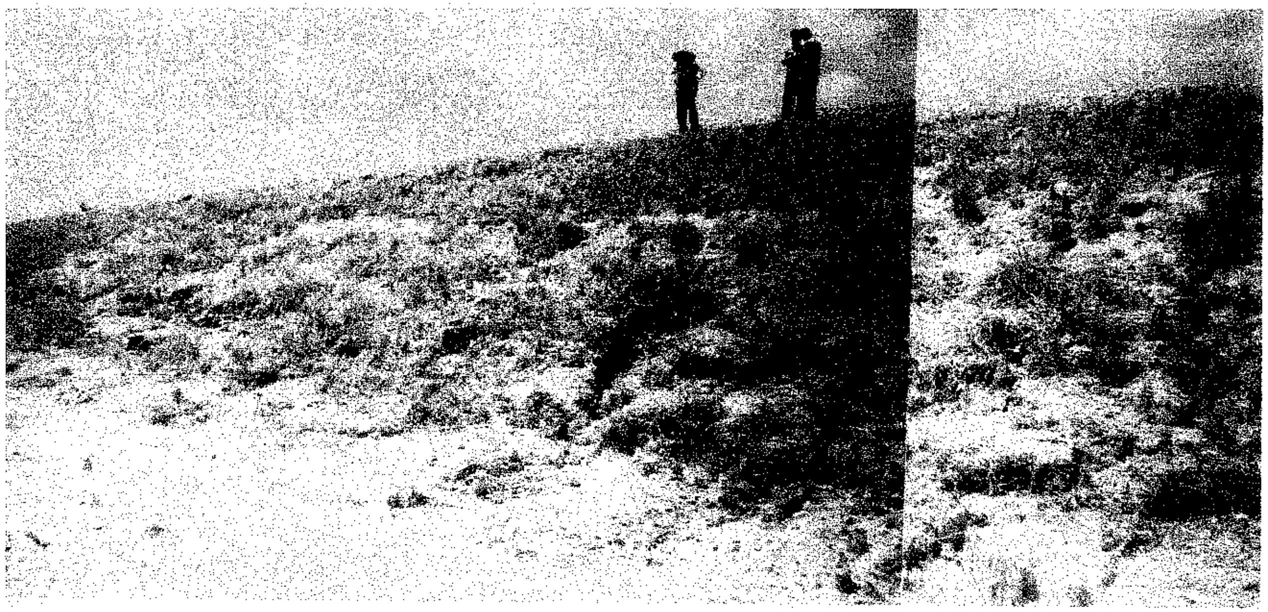


Photo C-10: Erosion of West Slope at CH 26+525 to CH 26+540

Photo C-11: Erosion of West Slope at CH 26+500 to CH 26+520

Photo C-12: Erosion of West Slope at CH 26+490 to CH 26+325

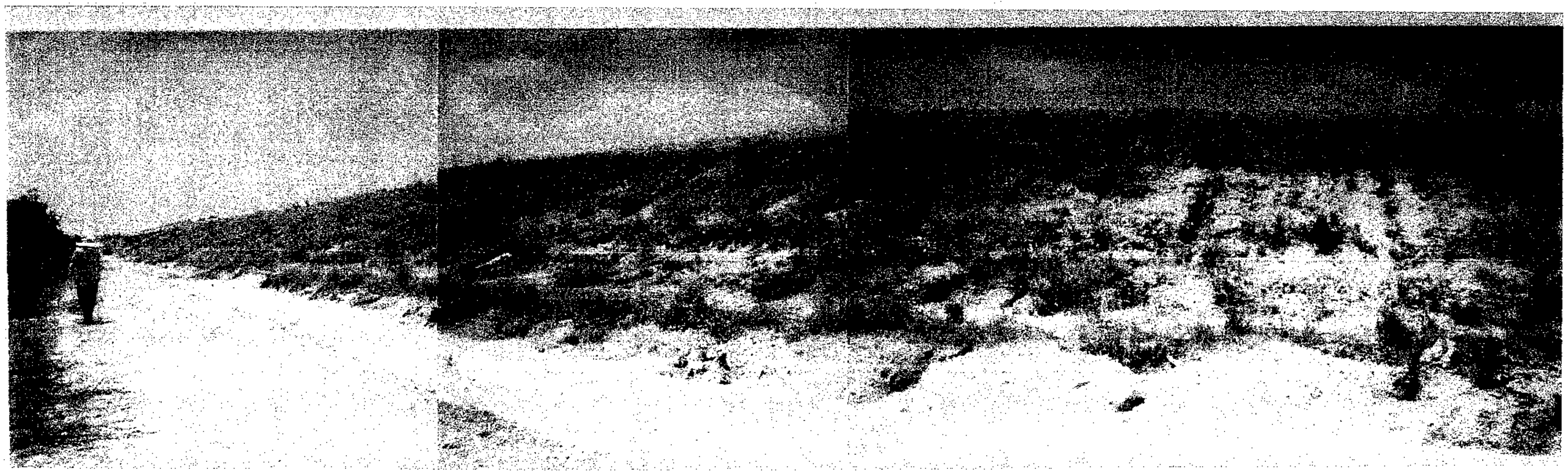


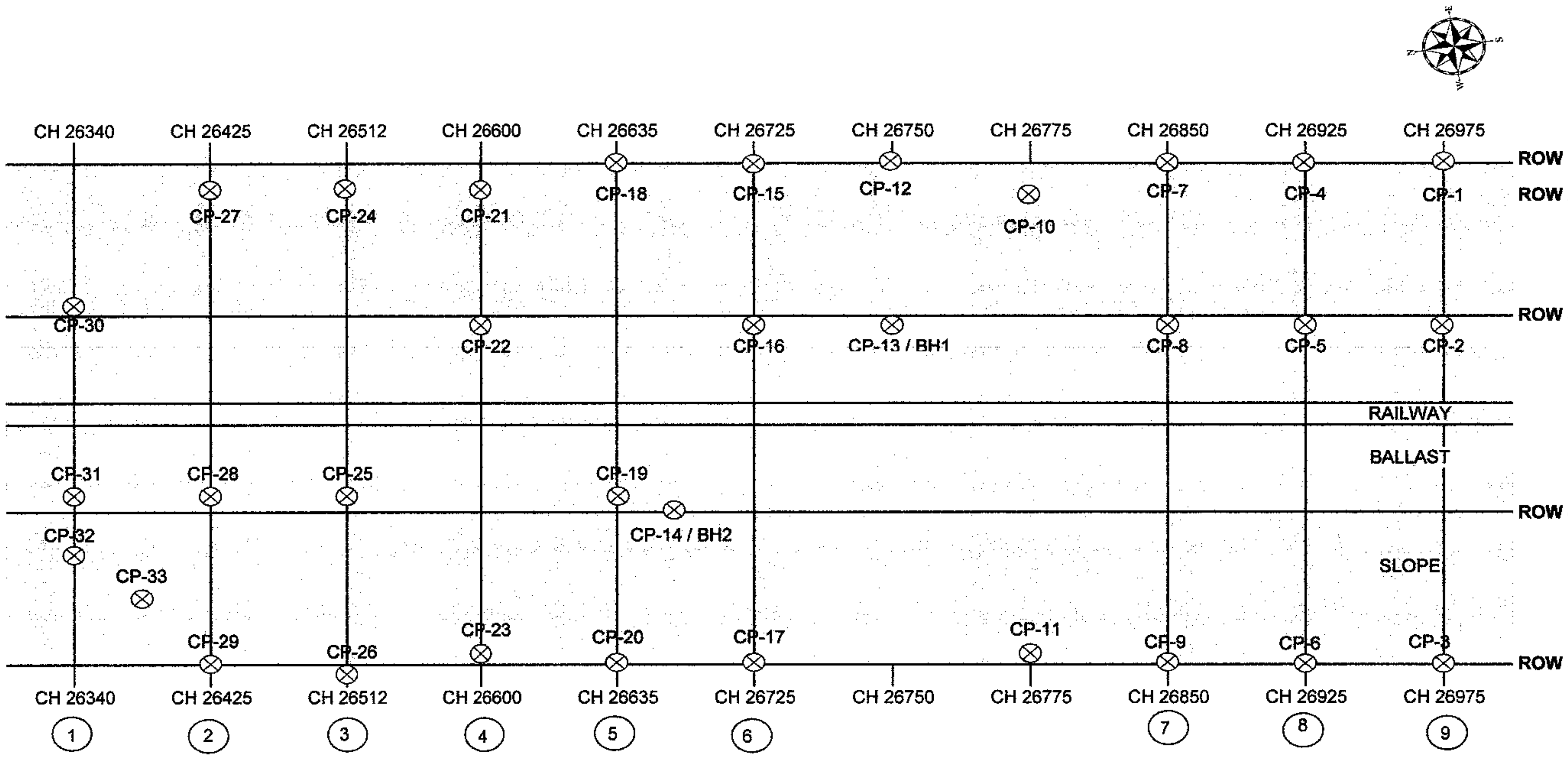
Photo C-13: Erosion on East Slope of CH 26+975

Photo C-14: Erosion on East Slope of CH 26+975

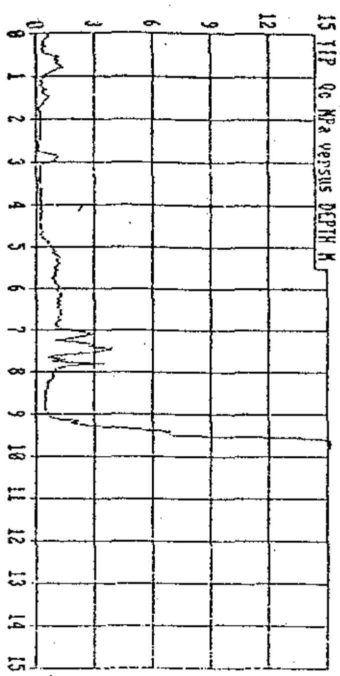
Photo C-15: Erosion of West Slope at CH 26+325

Appendix D

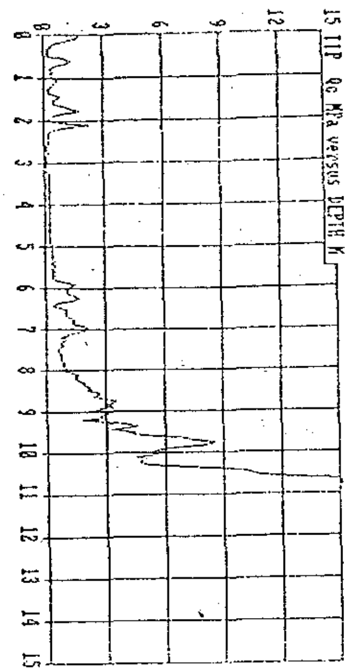
Assessment of Piezocone Penetration Test



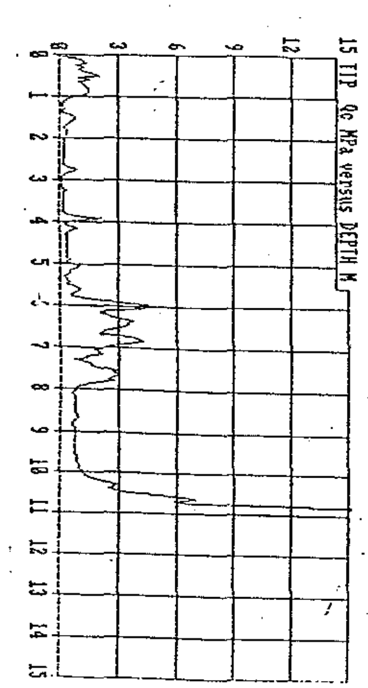
Piezocone & Borehole Layout Plan



LOCATION : KERTEH CH26.748
JOB No. : CP-12 (11.10mL)



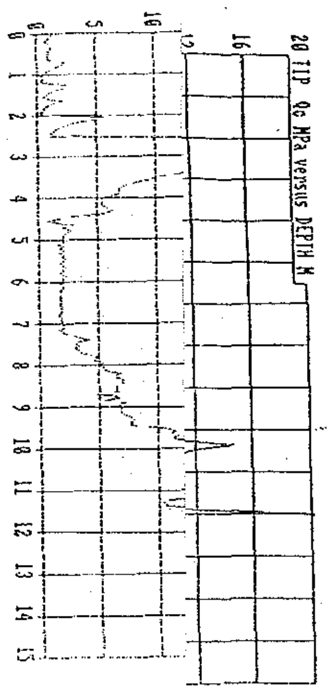
LOCATION : KERTEH CH26.975
JOB No. : CP-1 (10.40mL)



LOCATION : KERTEH CH26.725
JOB No. : CP-15 (12.30mL)

PIEZOCONE CONE LOG
Tip Resistance vs. Depth
(Eastern)

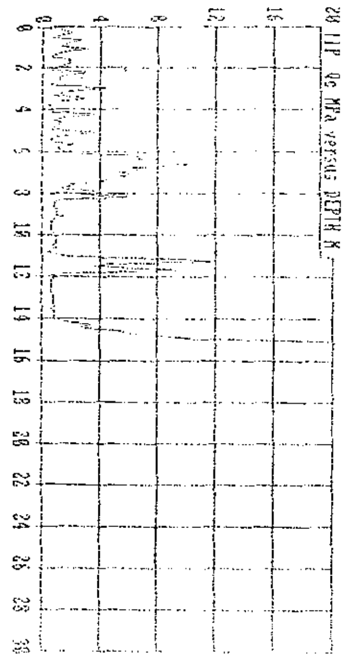
Drawing D2 – ROW 1



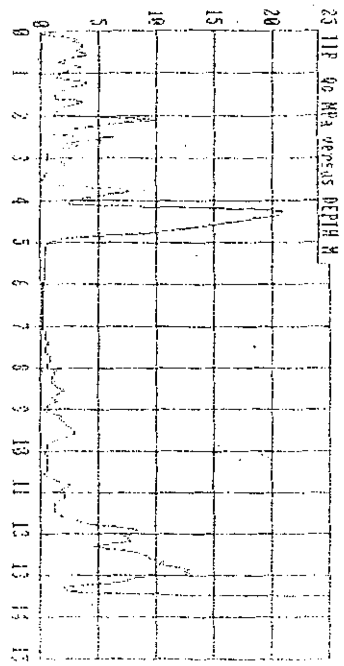
LOCATION : BERTH CH26.775
JOB No. : CP-27 (8.49mL)

PIEZOCONE CONE LOG
Tip Resistance vs. Depth
(Eastern)

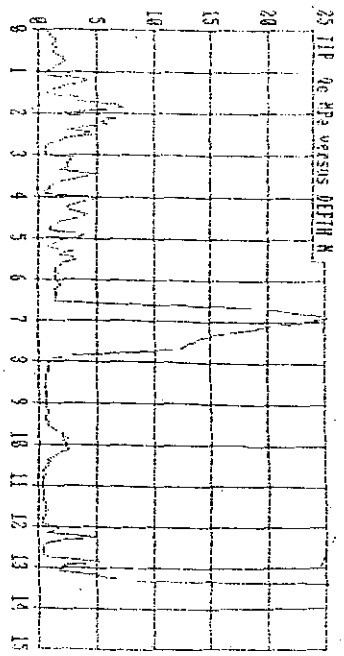
Drawing D3 – ROW 2



LOCATION : KERTEH CH26.725
JOB No. : CP-16 (3.95mL)



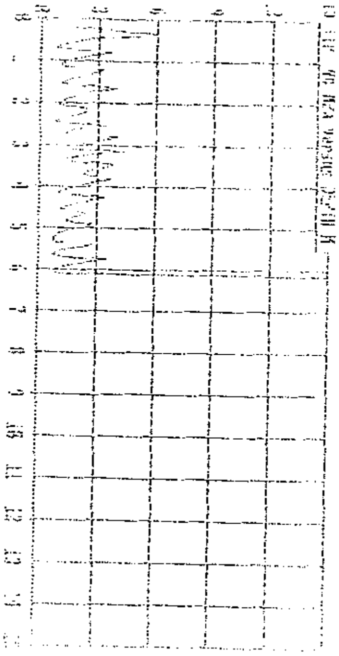
LOCATION : KERTEH CH26.975
JOB No. : CP-2 (3.80mL)



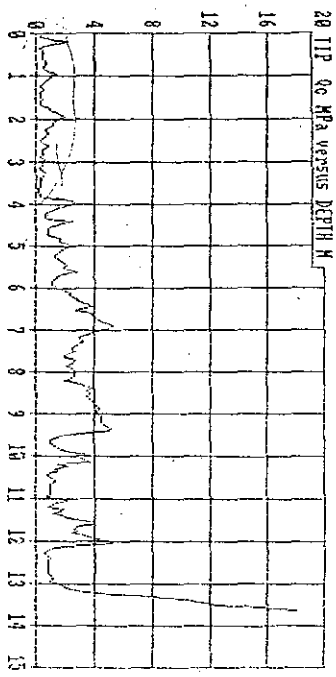
LOCATION : KERTEH CH26.600
JOB No. : CP-22 (4.20mL)

PIEZOCONE CONE LOG
Tip Resistance vs. Depth
(Eastern)

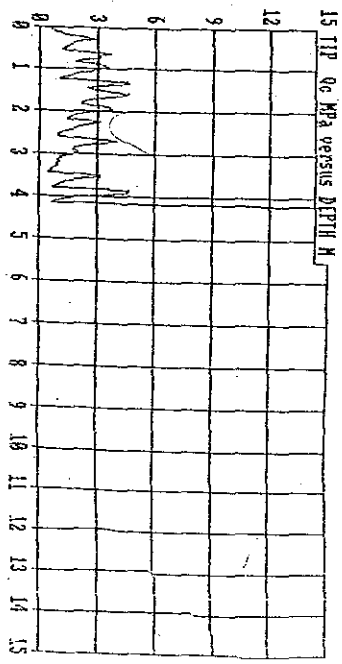
Drawing D4 – ROW 3



LOCATION : KERTEH CH26.340
JOB No. : CP-31 (3.30mR)



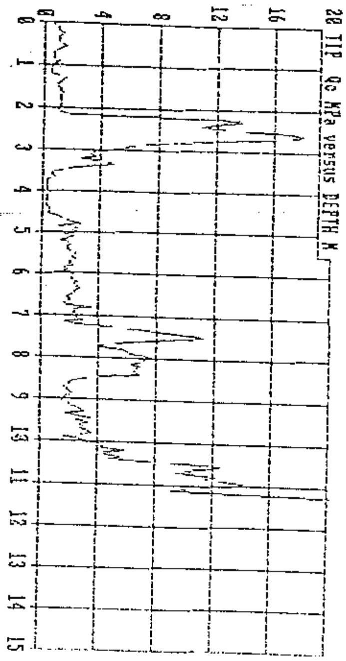
LOCATION : KERTEH CH26.640
JOB No. : CP-14 (4.80mR)



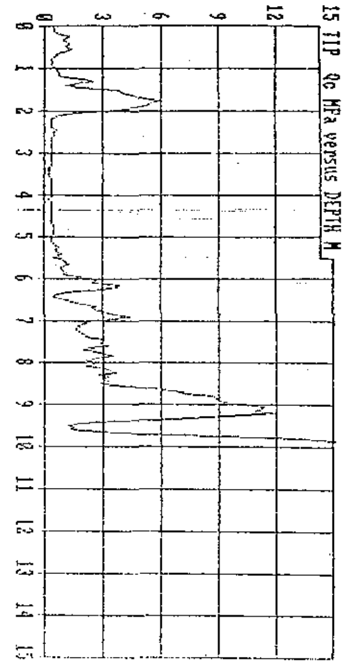
LOCATION : KERTEH CH26.343
JOB No. : CP-32 (7.30mR)

PIEZOCONE CONE LOG
Tip Resistance vs. Depth
(Western)

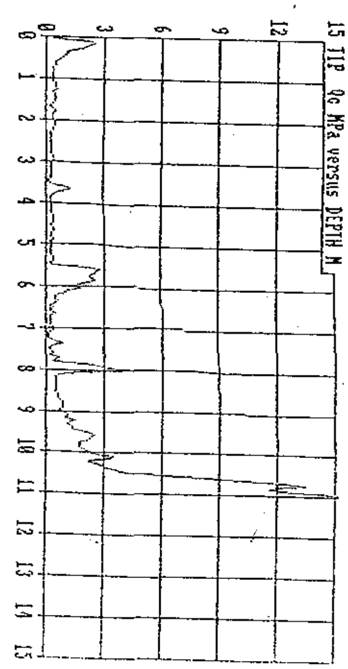
Drawing D5 – ROW 4



LOCATION : KERTEH CH26.725
JOB No. : CP-17 (11.30mR)



LOCATION : KERTEH CH26.975
JOB No. : CP-3 (9.05mR)



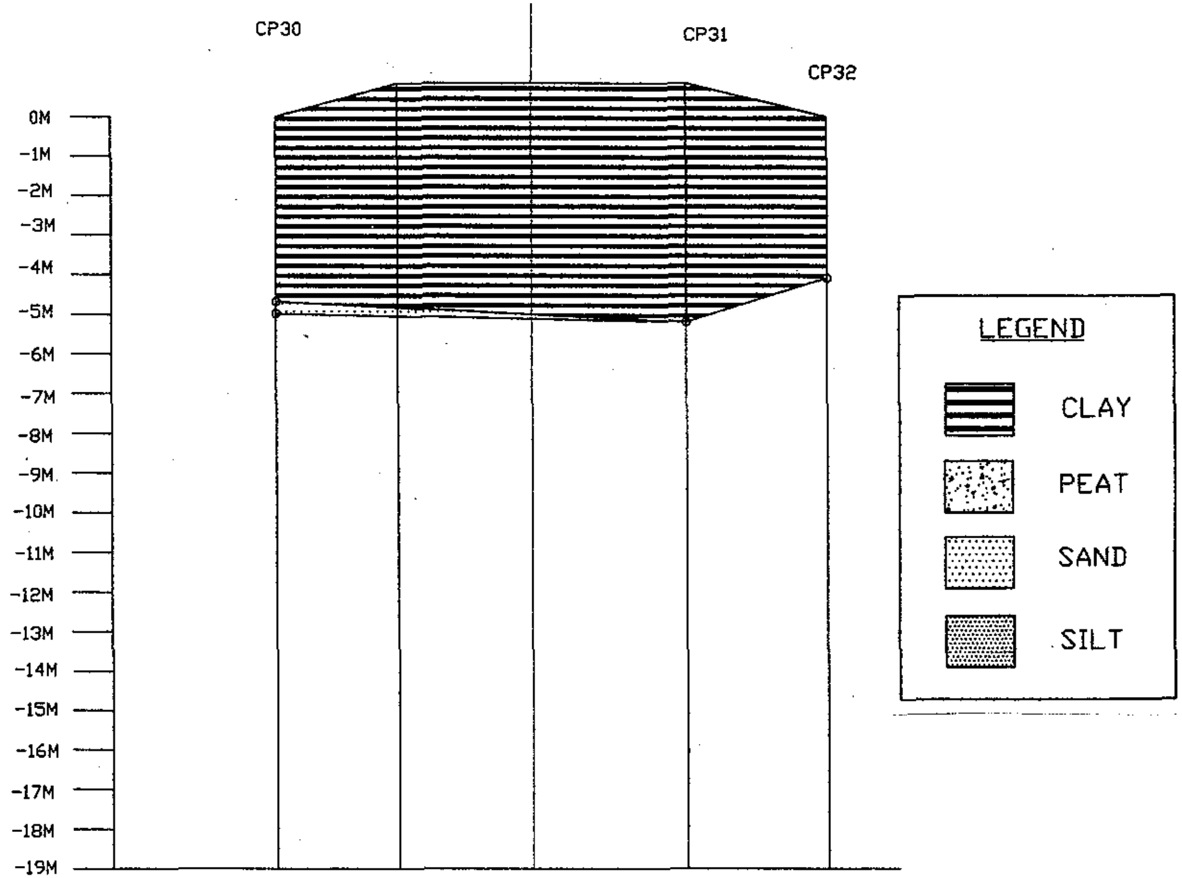
LOCATION : KERTEH CH26.635
JOB No. : CP-20 (12.70mR)

PIEZOCONE CONE LOG
Tip Resistance vs. Depth
(Western)

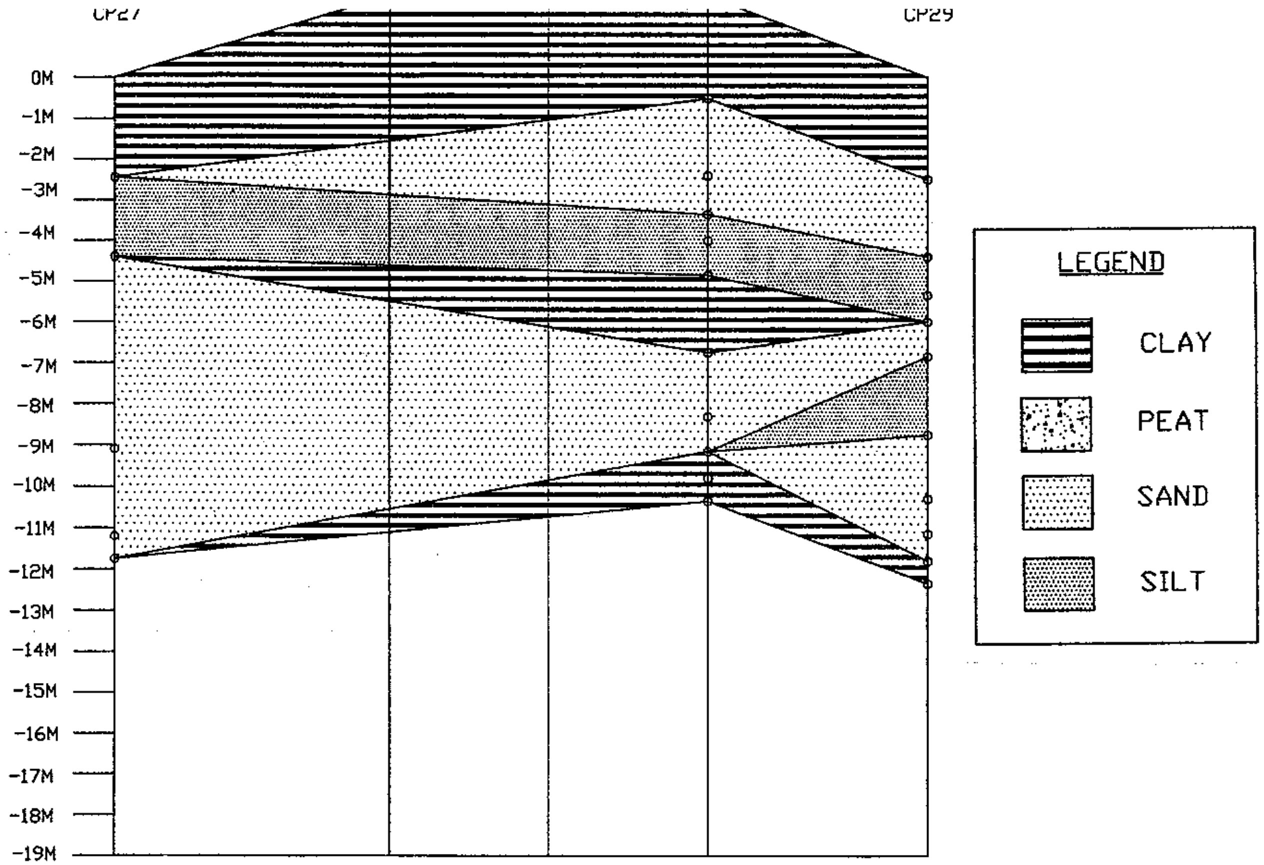
Drawing D6 – ROW 5

Appendix E

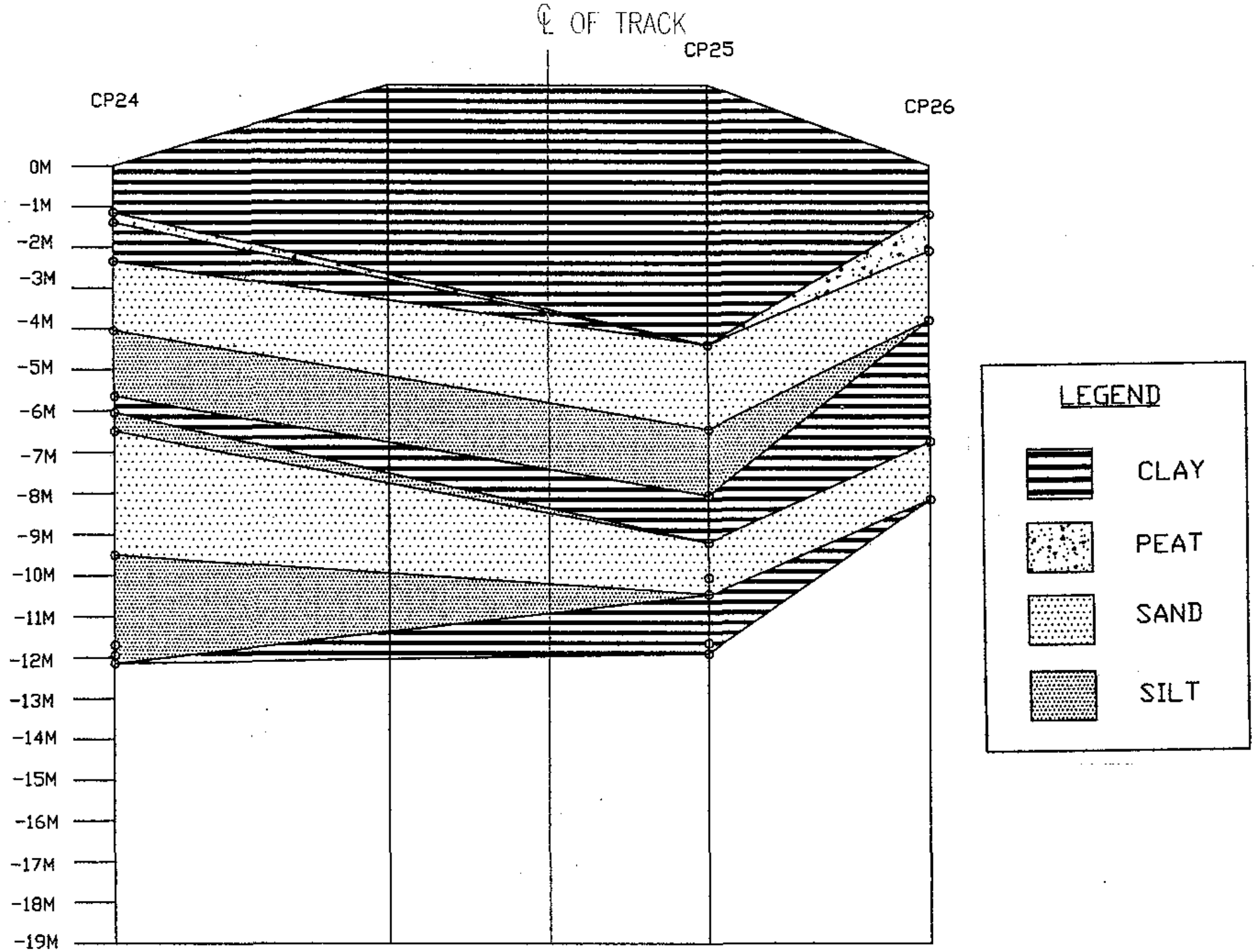
Cross Sections & Longitudinal Profiles



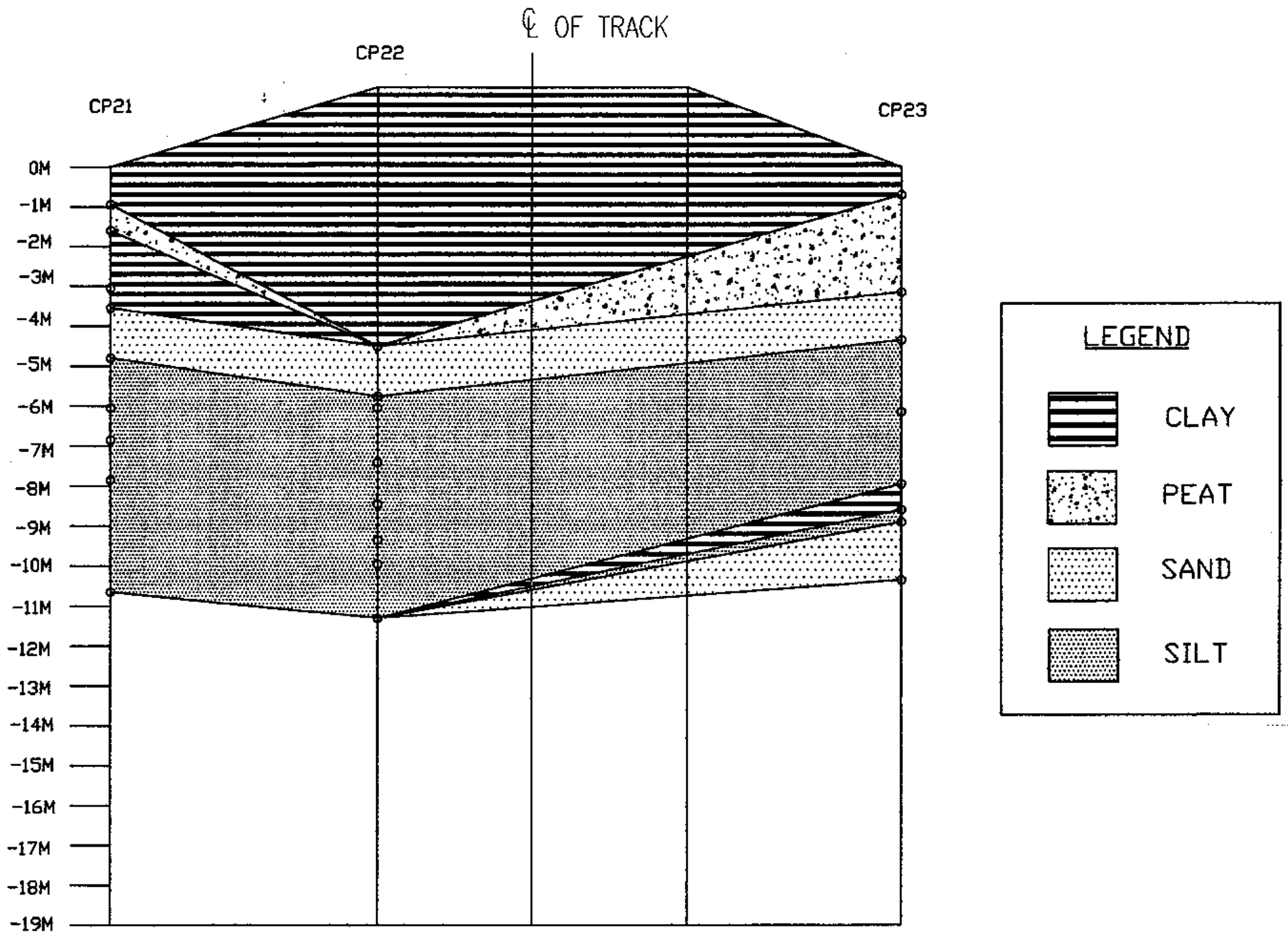
Cross Section 1
CH 26340



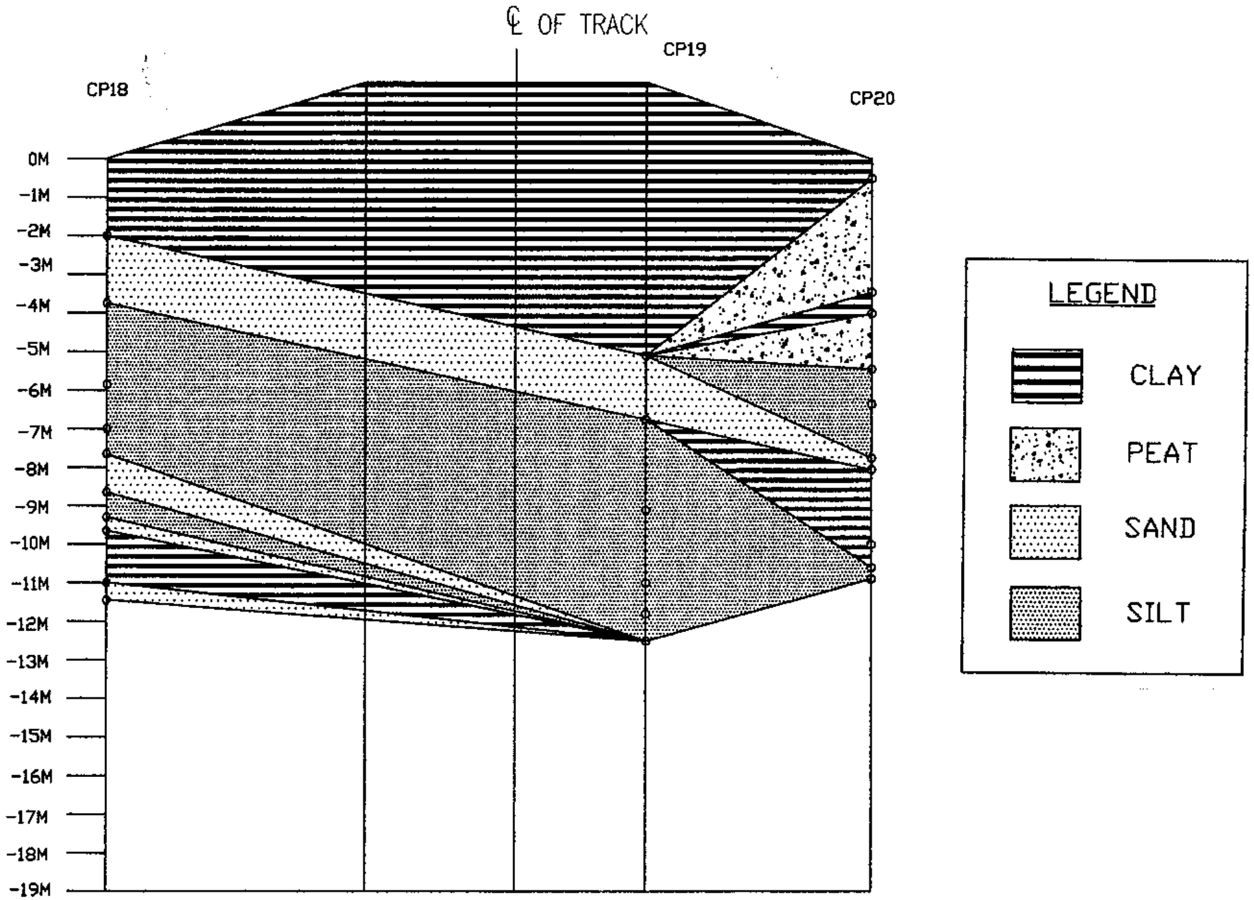
Cross Section 2
CH 26425



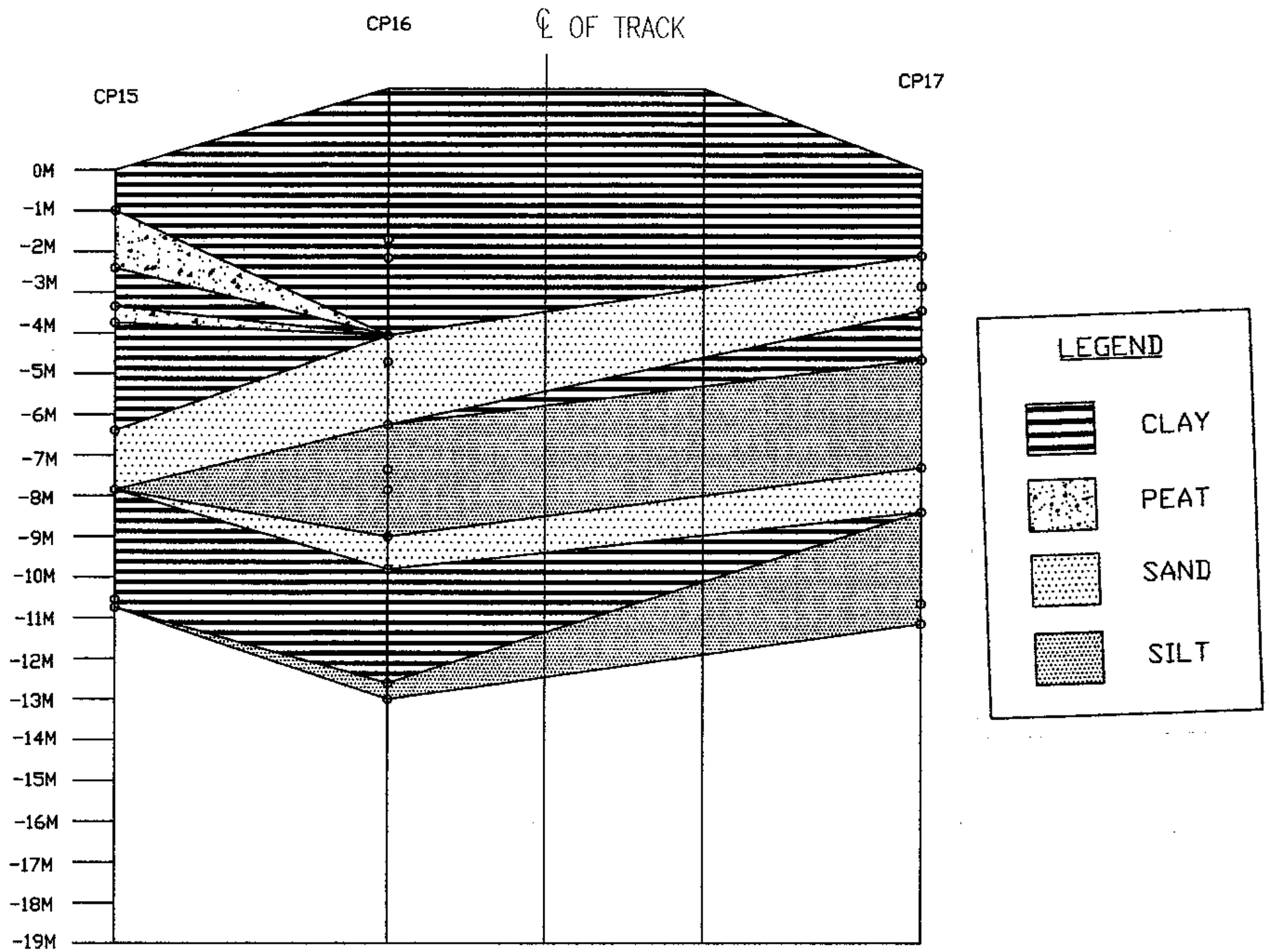
Cross Section 3
CH 26512



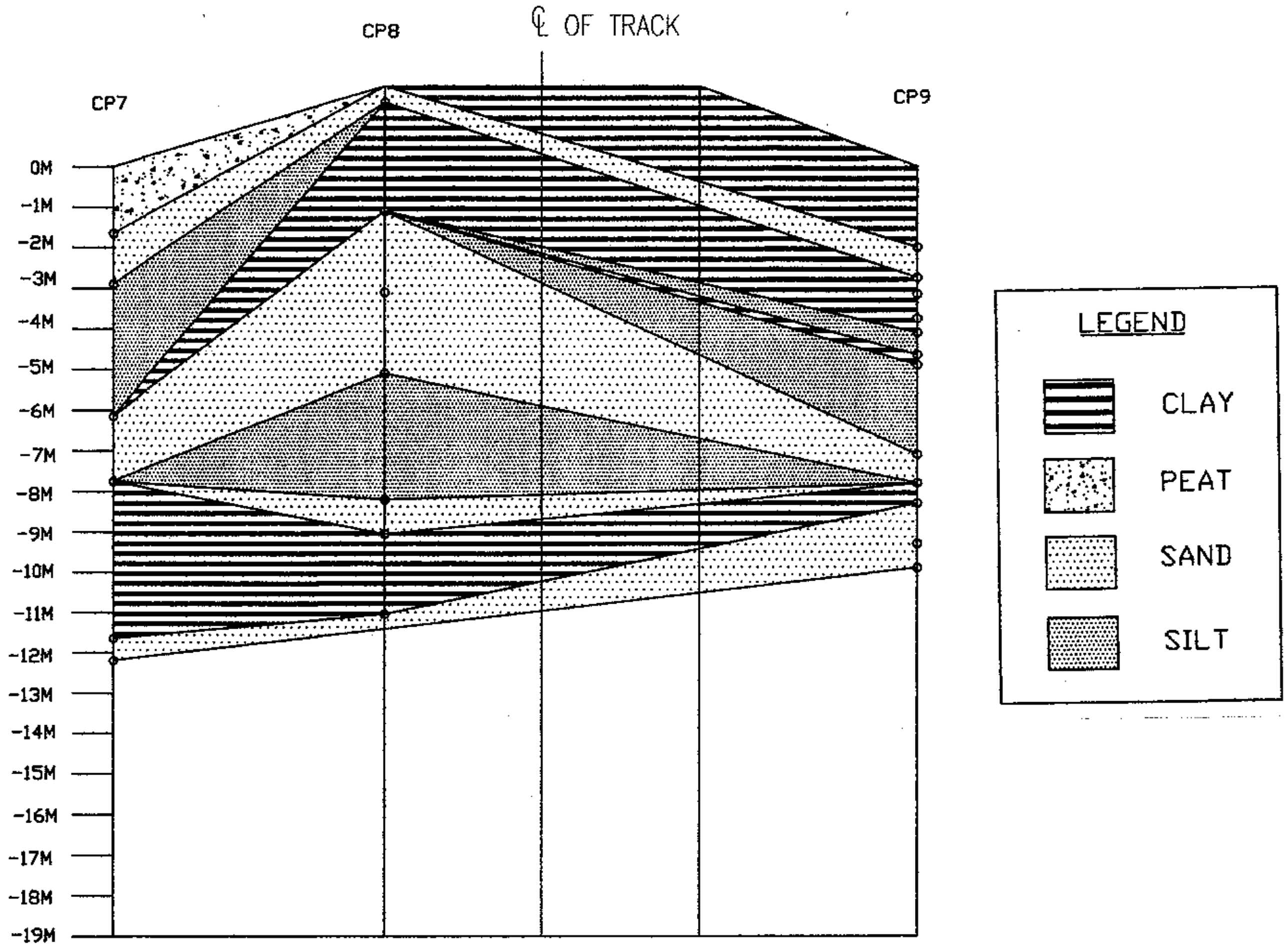
Cross Section 4
CH 26600



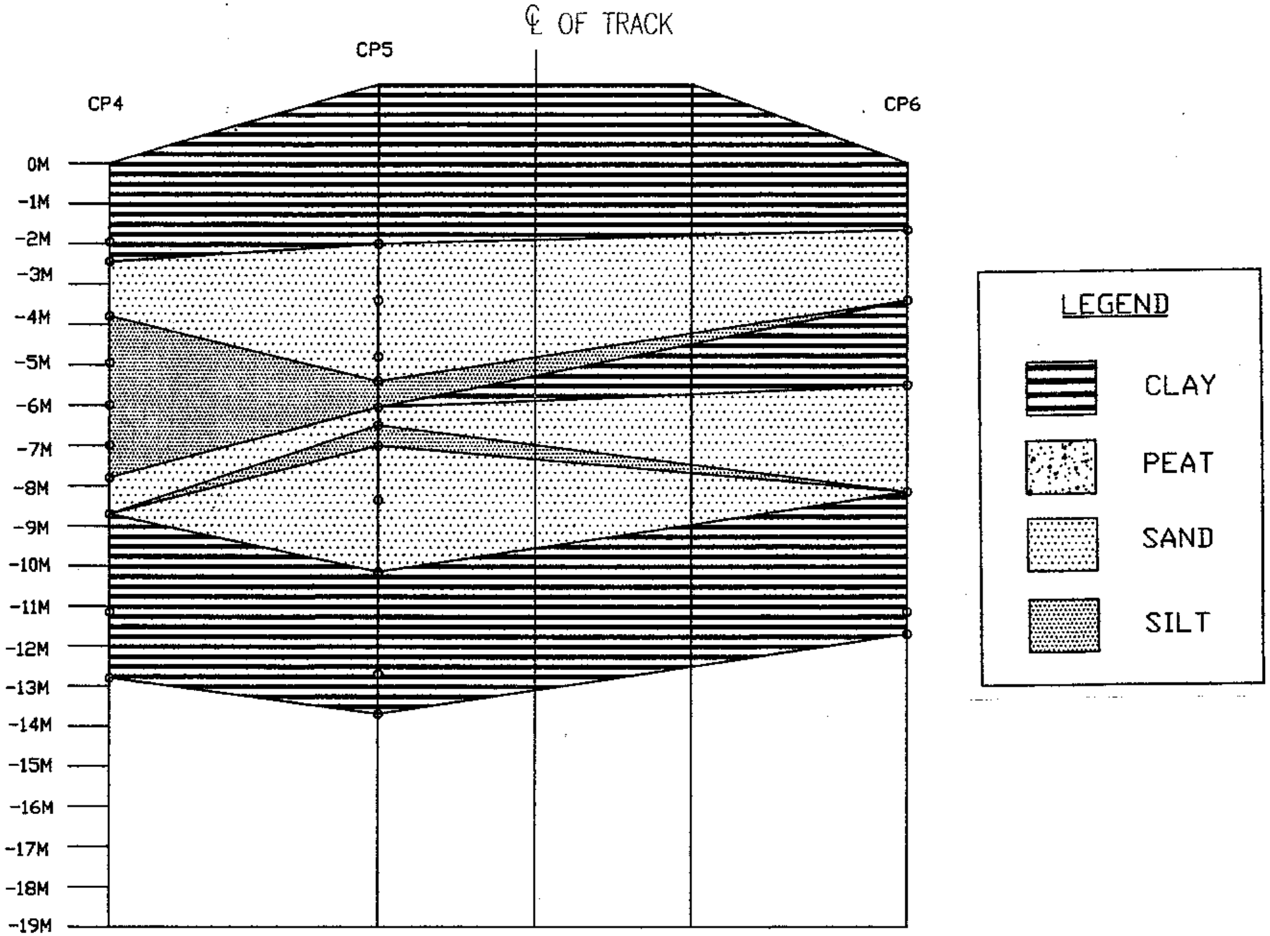
Cross Section 5
CH 26635



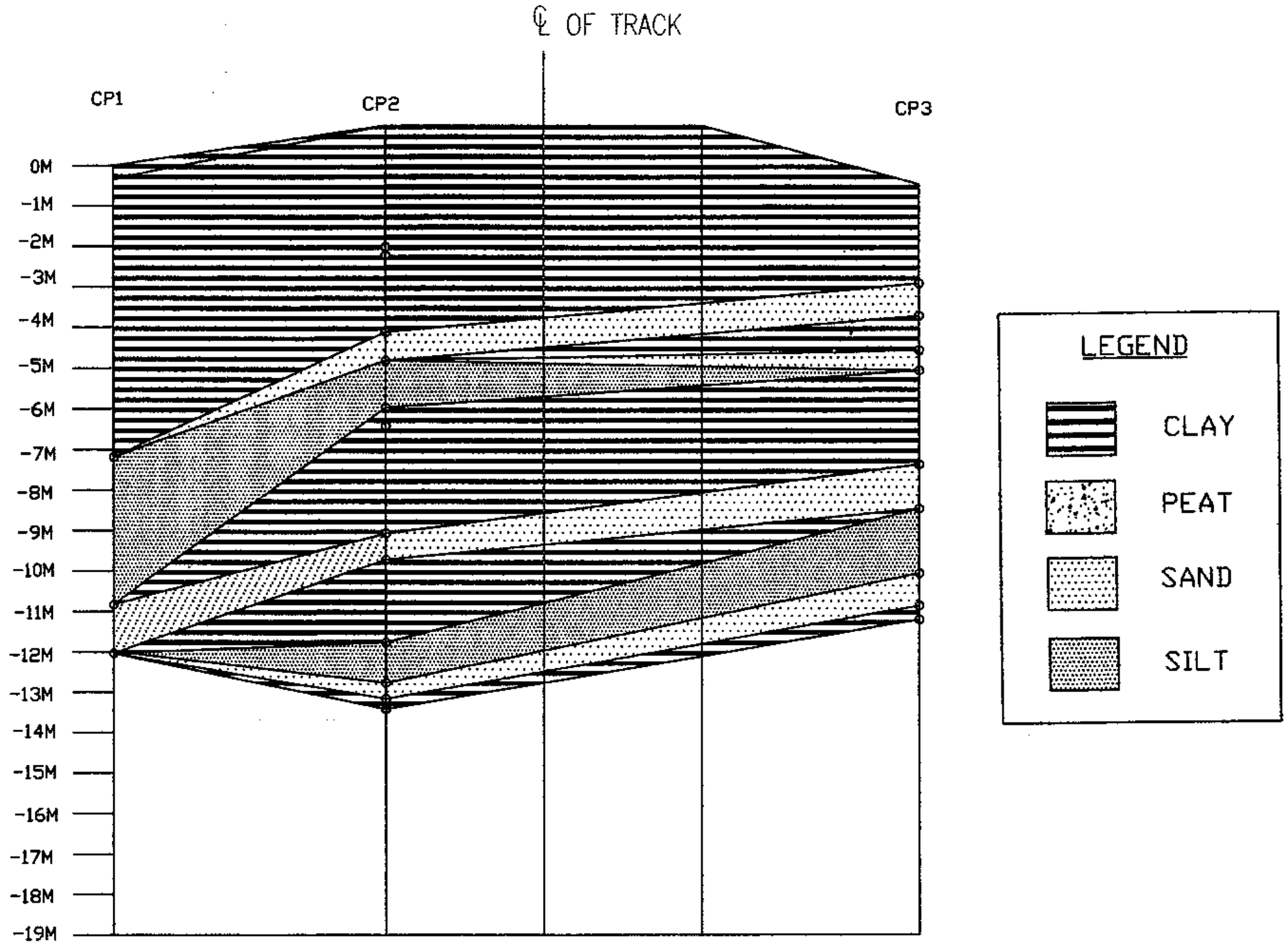
Cross Section 6
CH 26725



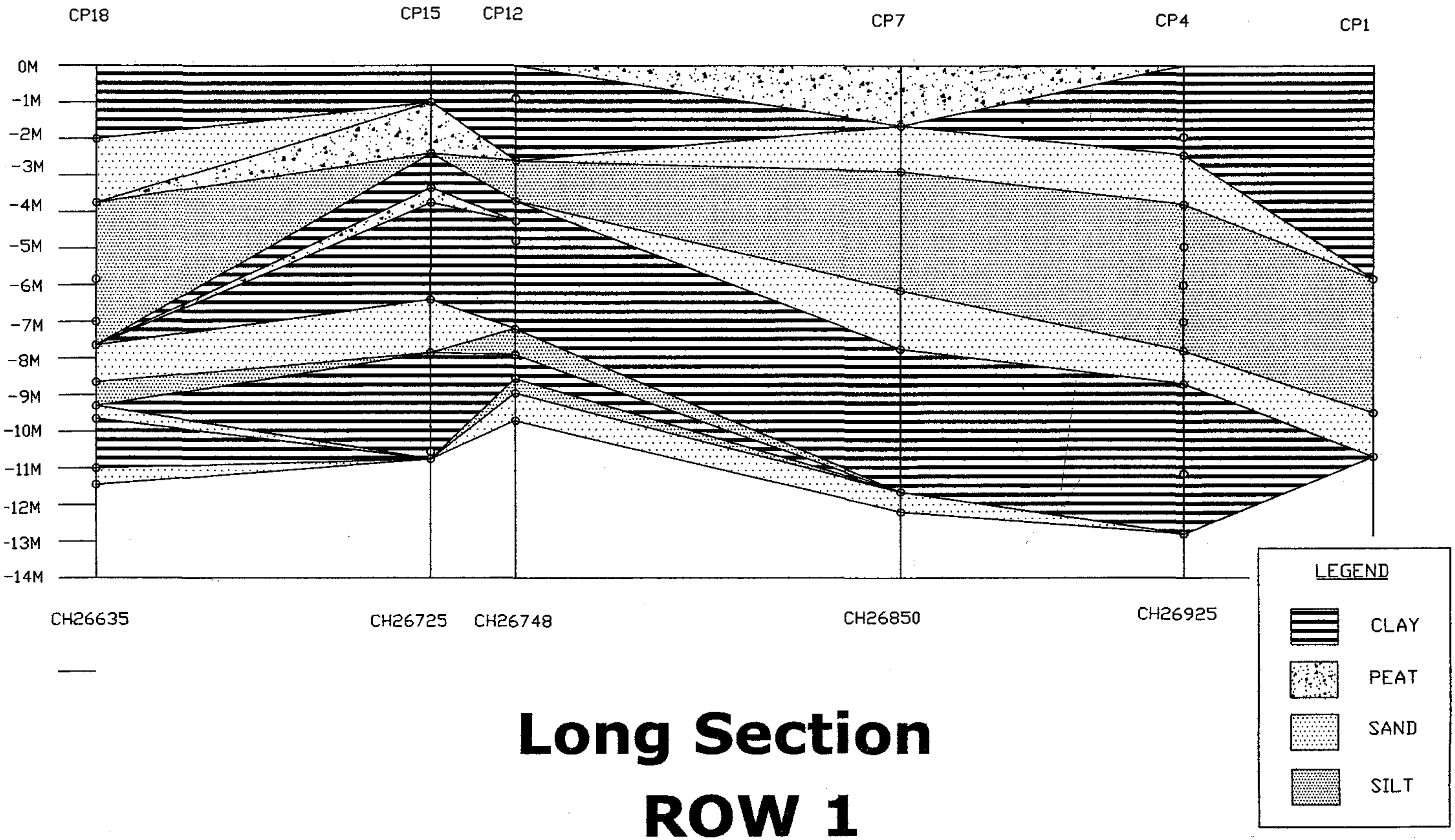
Cross Section 7
CH 26850



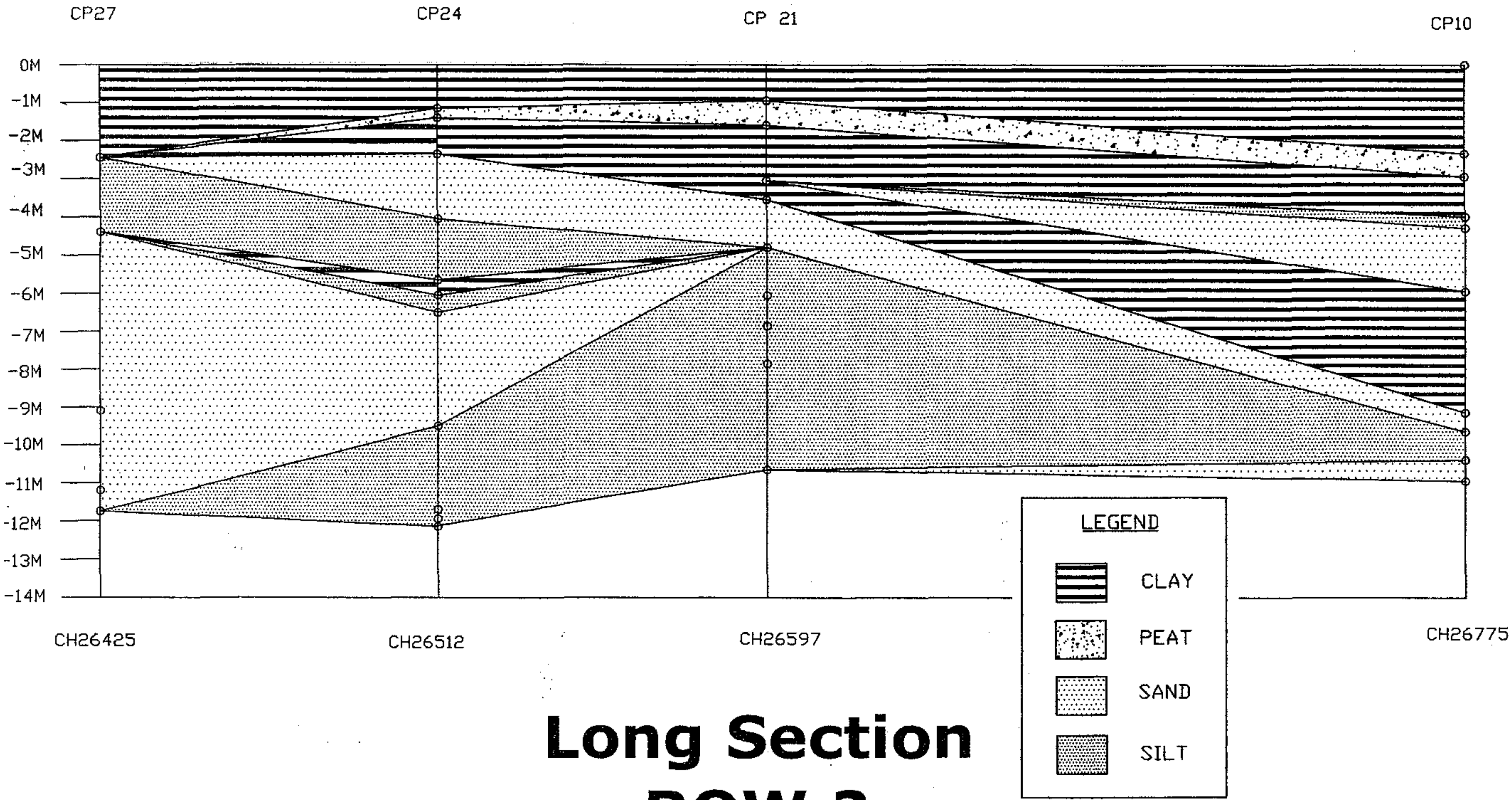
Cross Section 8
CH 26925



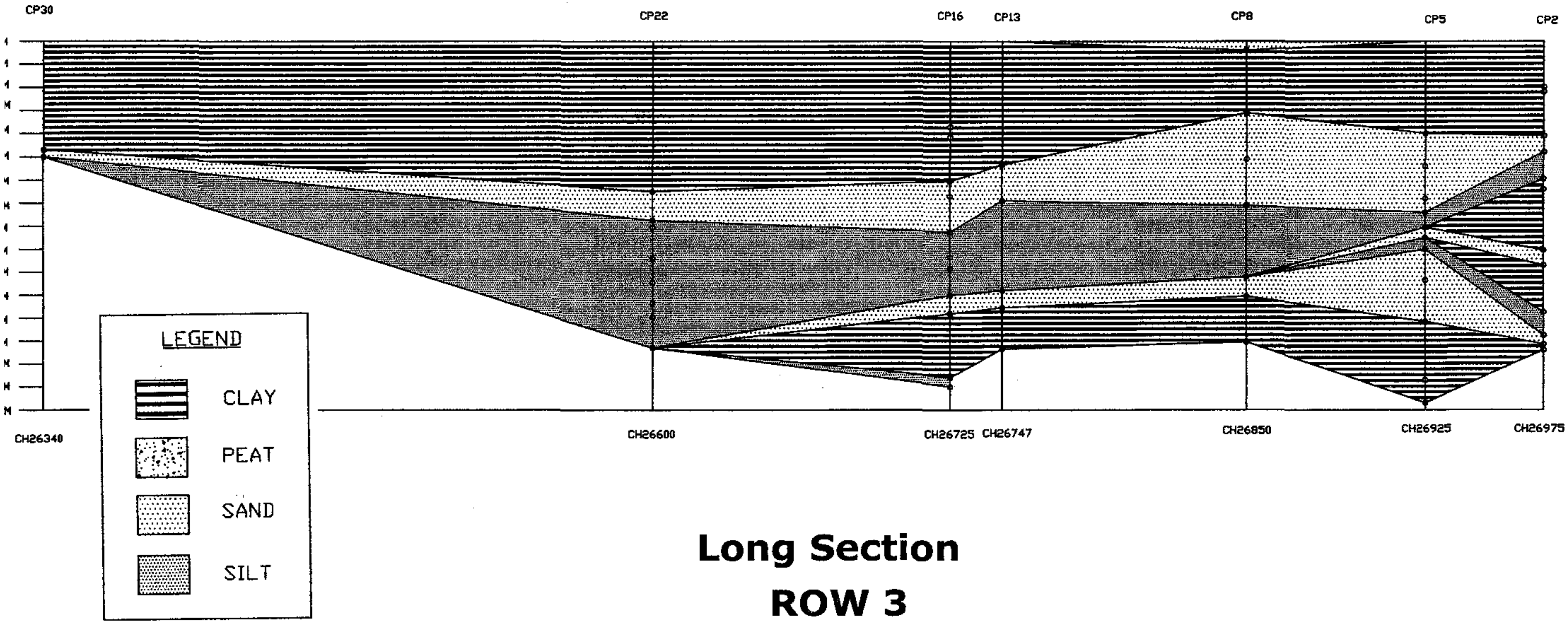
Cross Section 9
CH 26975



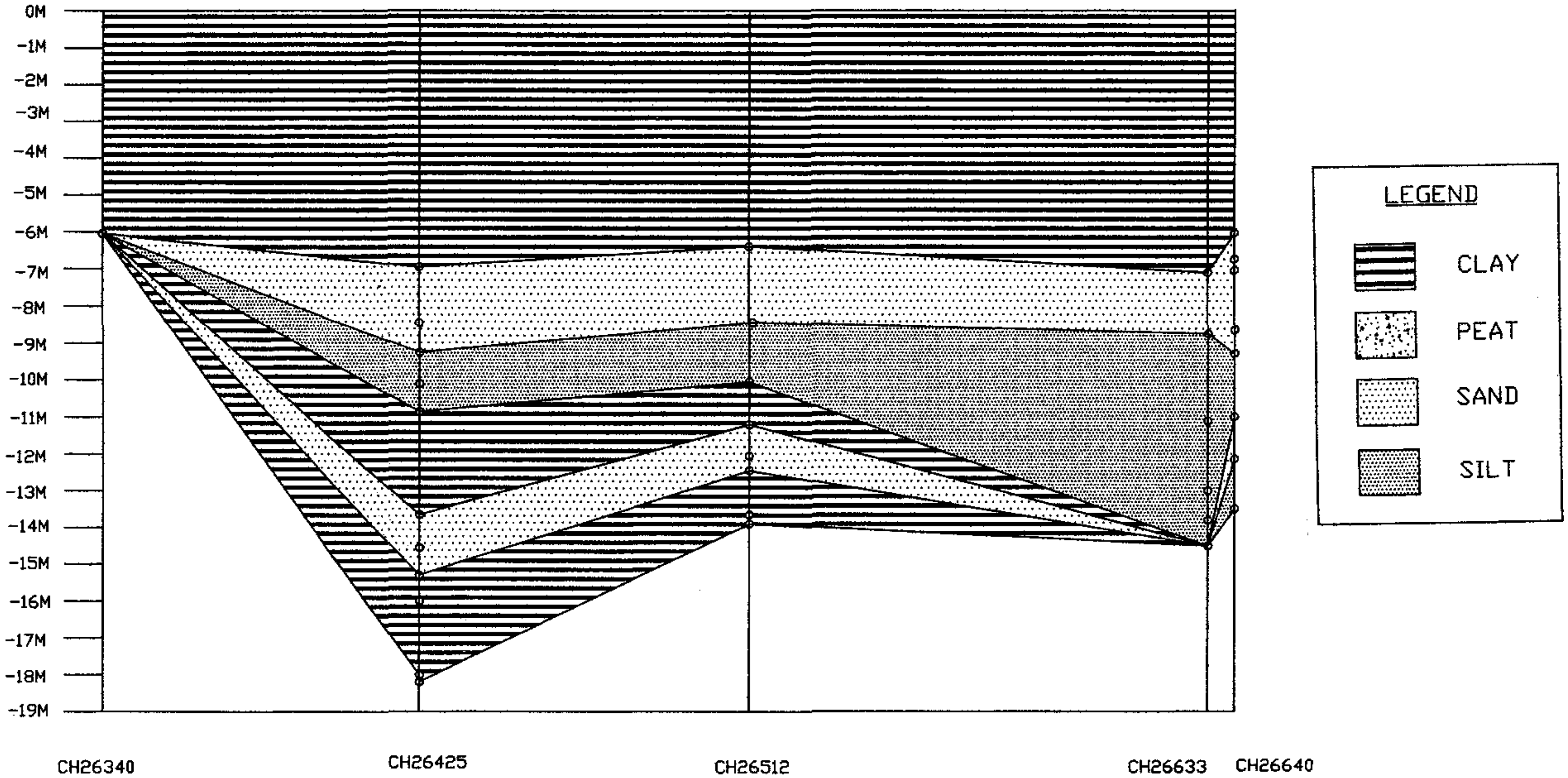
Long Section
ROW 1



Long Section ROW 2

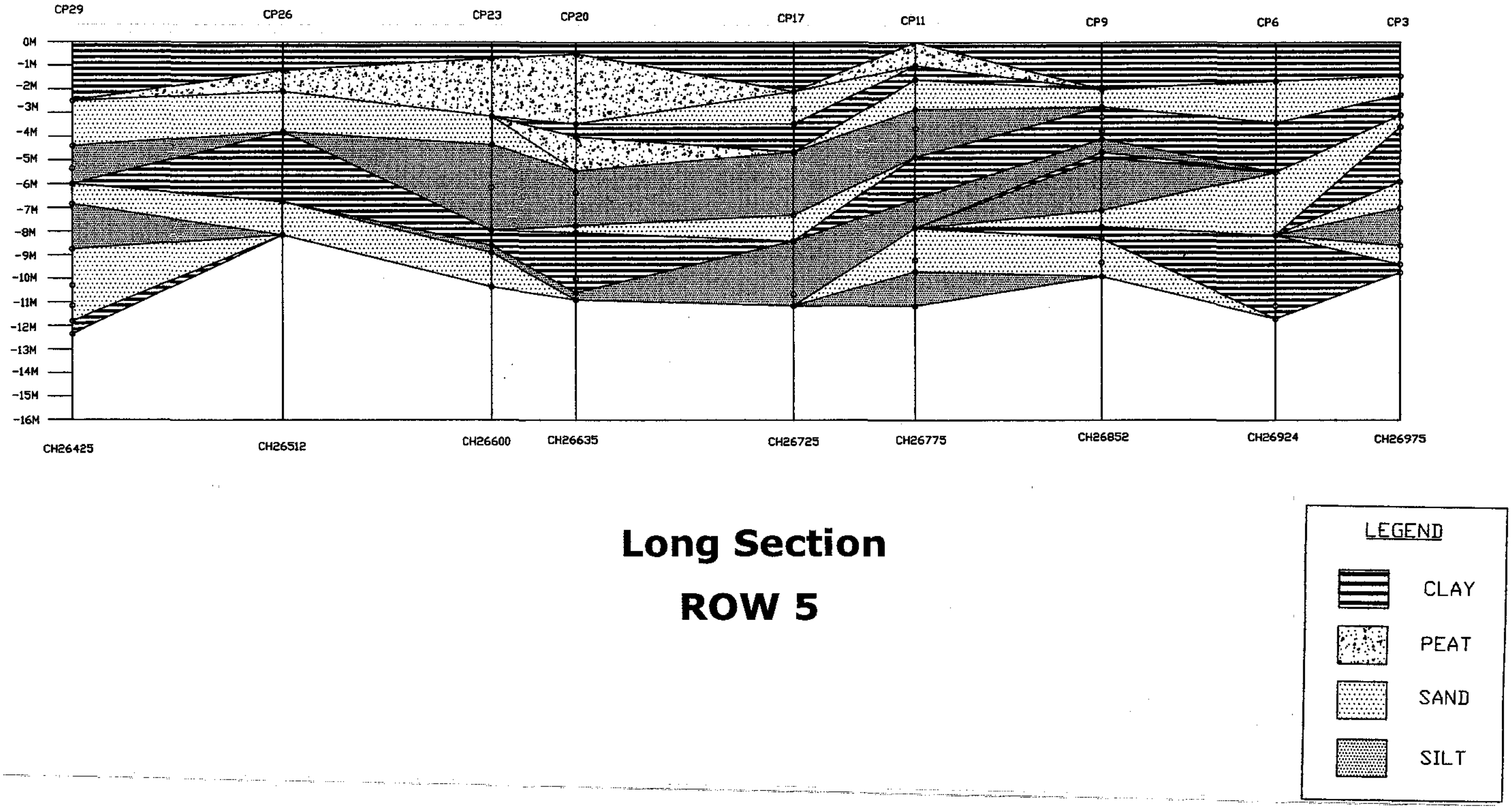


Long Section
ROW 3



Long Section

ROW 4



Long Section

ROW 5

Appendix F

Rainfall Data

PERKHIDMATAN KAJICUACA MALAYSIA
Records of Daily Rainfall Amount Data

Station : Hospital Kemaman
Lat. : 4° 14'N
Long. : 103° 25'E
Ht. Above M.S.L. : 3.1 m

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2001	1	1	0.0
49465	2001	1	2	26.5
49465	2001	1	3	115.2
49465	2001	1	4	0.0
49465	2001	1	5	0.0
49465	2001	1	6	1.7
49465	2001	1	7	0.0
49465	2001	1	8	0.0
49465	2001	1	9	0.0
49465	2001	1	10	0.0
49465	2001	1	11	0.0
49465	2001	1	12	0.0
49465	2001	1	13	0.0
49465	2001	1	14	0.0
49465	2001	1	15	19.2
49465	2001	1	16	42.8
49465	2001	1	17	50.7
49465	2001	1	18	155.6
49465	2001	1	19	133.2
49465	2001	1	20	21.0
49465	2001	1	21	13.0
49465	2001	1	22	2.0
49465	2001	1	23	0.0
49465	2001	1	24	60.5
49465	2001	1	25	0.0
49465	2001	1	26	20.4
49465	2001	1	27	0.0
49465	2001	1	28	0.0
49465	2001	1	29	0.0
49465	2001	1	30	0.0
49465	2001	1	31	0.0
49465	2001	2	1	0.0
49465	2001	2	2	0.0
49465	2001	2	3	0.0
49465	2001	2	4	0.0
49465	2001	2	5	9.0
49465	2001	2	6	3.7
49465	2001	2	7	0.0
49465	2001	2	8	3.5
49465	2001	2	9	0.0
49465	2001	2	10	0.0
49465	2001	2	11	0.0
49465	2001	2	12	0.0
49465	2001	2	13	0.0
49465	2001	2	14	22.0
49465	2001	2	15	0.0
49465	2001	2	16	1.0
49465	2001	2	17	0.0

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2001	2	18	0.0
49465	2001	2	19	2.5
49465	2001	2	20	0.0
49465	2001	2	21	0.0
49465	2001	2	22	0.0
49465	2001	2	23	0.0
49465	2001	2	24	1.1
49465	2001	2	25	0.0
49465	2001	2	26	0.0
49465	2001	2	27	0.0
49465	2001	2	28	0.0
49465	2001	3	1	0.0
49465	2001	3	2	1.2
49465	2001	3	3	0.0
49465	2001	3	4	28.3
49465	2001	3	5	179.5
49465	2001	3	6	18.5
49465	2001	3	7	7.0
49465	2001	3	8	0.0
49465	2001	3	9	18.0
49465	2001	3	10	0.0
49465	2001	3	11	0.0
49465	2001	3	12	0.0
49465	2001	3	13	0.0
49465	2001	3	14	26.2
49465	2001	3	15	0.0
49465	2001	3	16	28.9
49465	2001	3	17	0.0
49465	2001	3	18	0.0
49465	2001	3	19	34.5
49465	2001	3	20	12.8
49465	2001.	3	21	0.0
49465	2001	3	22	0.0
49465	2001	3	23	0.0
49465	2001	3	24	0.0
49465	2001	3	25	50.2
49465	2001	3	26	0.0
49465	2001	3	27	5.0
49465	2001	3	28	0.0
49465	2001	3	29	0.0
49465	2001	3	30	0.0
49465	2001	3	31	0.0
49465	2001	4	1	0.0
49465	2001	4	2	0.0
49465	2001	4	3	12.6
49465	2001	4	4	0.0
49465	2001	4	5	6.8
49465	2001	4	6	0.0
49465	2001	4	7	0.0
49465	2001	4	8	17.3
49465	2001	4	9	20.5
49465	2001	4	10	0.0
49465	2001	4	11	0.0
49465	2001	4	12	0.0
49465	2001	4	13	5.5
49465	2001	4	14	0.0

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2001	4	15	0.0
49465	2001	4	16	0.0
49465	2001	4	17	0.0
49465	2001	4	18	0.0
49465	2001	4	19	0.0
49465	2001	4	20	0.0
49465	2001	4	21	0.0
49465	2001	4	22	0.0
49465	2001	4	23	0.0
49465	2001	4	24	0.0
49465	2001	4	25	0.0
49465	2001	4	26	0.0
49465	2001	4	27	0.0
49465	2001	4	28	0.0
49465	2001	4	29	0.0
49465	2001	4	30	0.0
49465	2001	5	1	0.0
49465	2001	5	2	0.0
49465	2001	5	3	11.0
49465	2001	5	4	0.0
49465	2001	5	5	7.0
49465	2001	5	6	0.0
49465	2001	5	7	0.0
49465	2001	5	8	0.0
49465	2001	5	9	0.0
49465	2001	5	10	0.0
49465	2001	5	11	13.4
49465	2001	5	12	0.0
49465	2001	5	13	0.0
49465	2001	5	14	0.0
49465	2001	5	15	0.0
49465	2001	5	16	0.0
49465	2001	5	17	13.4
49465	2001	5	18	0.0
49465	2001	5	19	0.0
49465	2001	5	20	0.0
49465	2001	5	21	0.0
49465	2001	5	22	0.0
49465	2001	5	23	0.0
49465	2001	5	24	0.0
49465	2001	5	25	0.0
49465	2001	5	26	0.0
49465	2001	5	27	0.0
49465	2001	5	28	0.0
49465	2001	5	29	0.0
49465	2001	5	30	0.0
49465	2001	5	31	0.0
49465	2001	6	1	0.0
49465	2001	6	2	0.0
49465	2001	6	3	0.0
49465	2001	6	4	0.0
49465	2001	6	5	0.0
49465	2001	6	6	0.0
49465	2001	6	7	38.5
49465	2001	6	8	0.0
49465	2001	6	9	0.0

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2001	6	10	18.2
49465	2001	6	11	0.0
49465	2001	6	12	0.0
49465	2001	6	13	0.0
49465	2001	6	14	0.0
49465	2001	6	15	0.0
49465	2001	6	16	12.5
49465	2001	6	17	17.9
49465	2001	6	18	0.0
49465	2001	6	19	0.0
49465	2001	6	20	0.0
49465	2001	6	21	0.0
49465	2001	6	22	0.0
49465	2001	6	23	0.0
49465	2001	6	24	0.0
49465	2001	6	25	0.0
49465	2001	6	26	0.0
49465	2001	6	27	0.0
49465	2001	6	28	8.0
49465	2001	6	29	0.0
49465	2001	6	30	0.0
49465	2001	7	1	2.5
49465	2001	7	2	0.0
49465	2001	7	3	0.0
49465	2001	7	4	0.0
49465	2001	7	5	0.0
49465	2001	7	6	0.0
49465	2001	7	7	0.0
49465	2001	7	8	0.0
49465	2001	7	9	0.0
49465	2001	7	10	0.0
49465	2001	7	11	0.0
49465	2001	7	12	0.0
49465	2001	7	13	0.0
49465	2001	7	14	0.0
49465	2001	7	15	0.0
49465	2001	7	16	0.0
49465	2001	7	17	0.0
49465	2001	7	18	0.0
49465	2001	7	19	0.0
49465	2001	7	20	0.0
49465	2001	7	21	0.0
49465	2001	7	22	0.0
49465	2001	7	23	0.0
49465	2001	7	24	0.0
49465	2001	7	25	0.0
49465	2001	7	26	0.0
49465	2001	7	27	20.2
49465	2001	7	28	16.0
49465	2001	7	29	0.0
49465	2001	7	30	0.0
49465	2001	7	31	0.0
49465	2001	8	1	0.0
49465	2001	8	2	0.0
49465	2001	8	3	0.0
49465	2001	8	4	10.2

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2001	8	5	0.0
49465	2001	8	6	0.0
49465	2001	8	7	0.0
49465	2001	8	8	23.0
49465	2001	8	9	0.0
49465	2001	8	10	0.0
49465	2001	8	11	0.0
49465	2001	8	12	0.0
49465	2001	8	13	6.9
49465	2001	8	14	0.0
49465	2001	8	15	0.0
49465	2001	8	16	0.0
49465	2001	8	17	0.0
49465	2001	8	18	0.0
49465	2001	8	19	1.0
49465	2001	8	20	0.0
49465	2001	8	21	0.0
49465	2001	8	22	0.0
49465	2001	8	23	0.0
49465	2001	8	24	9.2
49465	2001	8	25	0.0
49465	2001	8	26	27.4
49465	2001	8	27	0.0
49465	2001	8	28	0.0
49465	2001	8	29	0.0
49465	2001	8	30	0.0
49465	2001	8	31	0.0
49465	2001	9	1	0.0
49465	2001	9	2	53.0
49465	2001	9	3	18.0
49465	2001	9	4	17.0
49465	2001	9	5	0.0
49465	2001	9	6	0.0
49465	2001	9	7	0.0
49465	2001	9	8	0.0
49465	2001	9	9	0.0
49465	2001	9	10	0.0
49465	2001	9	11	0.0
49465	2001	9	12	0.0
49465	2001	9	13	0.0
49465	2001	9	14	0.0
49465	2001	9	15	0.0
49465	2001	9	16	0.0
49465	2001	9	17	10.6
49465	2001	9	18	0.0
49465	2001	9	19	3.0
49465	2001	9	20	2.0
49465	2001	9	21	0.0
49465	2001	9	22	15.2
49465	2001	9	23	40.8
49465	2001	9	24	0.0
49465	2001	9	25	0.0
49465	2001	9	26	20.4
49465	2001	9	27	8.0
49465	2001	9	28	0.0
49465	2001	9	29	0.0

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2001	9	30	0.0
49465	2001	10	1	25.5
49465	2001	10	2	32.6
49465	2001	10	3	0.0
49465	2001	10	4	3.0
49465	2001	10	5	0.0
49465	2001	10	6	0.0
49465	2001	10	7	0.0
49465	2001	10	8	45.2
49465	2001	10	9	0.0
49465	2001	10	10	0.0
49465	2001	10	11	0.0
49465	2001	10	12	2.0
49465	2001	10	13	0.0
49465	2001	10	14	0.2
49465	2001	10	15	0.0
49465	2001	10	16	10.0
49465	2001	10	17	13.0
49465	2001	10	18	25.5
49465	2001	10	19	-33.3
49465	2001	10	20	0.0
49465	2001	10	21	9.8
49465	2001	10	22	14.2
49465	2001	10	23	8.0
49465	2001	10	24	0.0
49465	2001	10	25	5.2
49465	2001	10	26	15.2
49465	2001	10	27	0.0
49465	2001	10	28	24.4
49465	2001	10	29	30.1
49465	2001	10	30	15.6
49465	2001	10	31	0.0
49465	2001	11	1	0.0
49465	2001	11	2	0.0
49465	2001	11	3	8.0
49465	2001	11	4	7.6
49465	2001	11	5	20.2
49465	2001	11	6	15.4
49465	2001	11	7	0.0
49465	2001	11	8	0.4
49465	2001	11	9	0.0
49465	2001	11	10	0.0
49465	2001	11	11	0.0
49465	2001	11	12	0.0
49465	2001	11	13	0.0
49465	2001	11	14	120.6
49465	2001	11	15	140.6
49465	2001	11	16	100.2
49465	2001	11	17	90.6
49465	2001	11	18	40.4
49465	2001	11	19	30.6
49465	2001	11	20	0.5
49465	2001	11	21	0.0
49465	2001	11	22	9.0
49465	2001	11	23	11.0
49465	2001	11	24	13.0

Stnnc	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2001	11	25	39.5
49465	2001	11	26	5.0
49465	2001	11	27	0.0
49465	2001	11	28	0.0
49465	2001	11	29	24.6
49465	2001	11	30	0.0
49465	2001	12	1	0.0
49465	2001	12	2	0.0
49465	2001	12	3	0.0
49465	2001	12	4	0.0
49465	2001	12	5	0.0
49465	2001	12	6	0.0
49465	2001	12	7	22.2
49465	2001	12	8	0.0
49465	2001	12	9	0.0
49465	2001	12	10	0.0
49465	2001	12	11	0.0
49465	2001	12	12	0.0
49465	2001	12	13	0.0
49465	2001	12	14	348.0
49465	2001	12	15	0.0
49465	2001	12	16	86.4
49465	2001	12	17	80.6
49465	2001	12	18	20.2
49465	2001	12	19	6.0
49465	2001	12	20	45.0
49465	2001	12	21	55.0
49465	2001	12	22	75.0
49465	2001	12	23	0.0
49465	2001	12	24	65.2
49465	2001	12	25	30.2
49465	2001	12	26	10.4
49465	2001	12	27	60.2
49465	2001	12	28	40.0
49465	2001	12	29	60.6
49465	2001	12	30	60.4
49465	2001	12	31	0.0
49465	2002	1	1	0.0
49465	2002	1	2	0.0
49465	2002	1	3	0.0
49465	2002	1	4	0.0
49465	2002	1	5	0.0
49465	2002	1	6	16.2
49465	2002	1	7	6.8
49465	2002	1	8	6.0
49465	2002	1	9	5.2
49465	2002	1	10	0.0
49465	2002	1	11	0.0
49465	2002	1	12	0.0
49465	2002	1	13	0.0
49465	2002	1	14	0.0
49465	2002	1	15	0.0
49465	2002	1	16	0.0
49465	2002	1	17	0.0
49465	2002	1	18	0.0
49465	2002	1	19	20.2

Stnno	Year	Month	Day	Rainfall (06-06 MST) (mm)
49465	2002	1	20	0.0
49465	2002	1	21	0.0
49465	2002	1	22	12.6
49465	2002	1	23	0.0
49465	2002	1	24	0.0
49465	2002	1	25	0.0
49465	2002	1	26	15.0
49465	2002	1	27	0.6
49465	2002	1	28	0.0
49465	2002	1	29	0.0
49465	2002	1	30	0.0
49465	2002	1	31	0.0
49465	2002	2	1	0.0
49465	2002	2	2	0.0
49465	2002	2	3	0.0
49465	2002	2	4	0.0
49465	2002	2	5	0.0
49465	2002	2	6	1.0
49465	2002	2	7	0.0
49465	2002	2	8	0.0
49465	2002	2	9	0.0
49465	2002	2	10	0.0
49465	2002	2	11	0.0
49465	2002	2	12	0.0
49465	2002	2	13	0.0
49465	2002	2	14	0.0
49465	2002	2	15	0.0
49465	2002	2	16	0.0
49465	2002	2	17	0.0
49465	2002	2	18	0.0
49465	2002	2	19	0.0
49465	2002	2	20	0.0
49465	2002	2	21	0.0
49465	2002	2	22	0.0
49465	2002	2	23	0.0
49465	2002	2	24	0.0
49465	2002	2	25	0.0
49465	2002	2	26	0.0
49465	2002	2	27	0.0
49465	2002	2	28	0.0
49465	2002	3	1	0.0
49465	2002	3	2	5.5
49465	2002	3	3	0.0
49465	2002	3	4	0.0
49465	2002	3	5	0.0
49465	2002	3	6	0.0
49465	2002	3	7	0.0
49465	2002	3	8	0.0
49465	2002	3	9	5.0
49465	2002	3	10	0.0
49465	2002	3	11	0.0
49465	2002	3	12	0.0
49465	2002	3	13	0.0
49465	2002	3	14	0.0
49465	2002	3	15	0.0
49465	2002	3	16	0.0

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2002	3	17	0.0
49465	2002	3	18	0.0
49465	2002	3	19	0.0
49465	2002	3	20	0.0
49465	2002	3	21	102.0
49465	2002	3	22	80.0
49465	2002	3	23	0.0
49465	2002	3	24	0.0
49465	2002	3	25	0.0
49465	2002	3	26	0.0
49465	2002	3	27	0.0
49465	2002	3	28	0.0
49465	2002	3	29	0.0
49465	2002	3	30	0.0
49465	2002	3	31	0.0
49465	2002	4	1	0.0
49465	2002	4	2	0.0
49465	2002	4	3	0.0
49465	2002	4	4	0.0
49465	2002	4	5	0.0
49465	2002	4	6	20.6
49465	2002	4	7	32.8
49465	2002	4	8	0.0
49465	2002	4	9	0.0
49465	2002	4	10	0.0
49465	2002	4	11	0.0
49465	2002	4	12	0.0
49465	2002	4	13	0.0
49465	2002	4	14	0.0
49465	2002	4	15	0.0
49465	2002	4	16	0.0
49465	2002	4	17	1.0
49465	2002	4	18	0.0
49465	2002	4	19	0.0
49465	2002	4	20	2.0
49465	2002	4	21	0.0
49465	2002	4	22	0.0
49465	2002	4	23	0.0
49465	2002	4	24	0.0
49465	2002	4	25	0.0
49465	2002	4	26	0.0
49465	2002	4	27	0.0
49465	2002	4	28	0.0
49465	2002	4	29	0.0
49465	2002	4	30	0.0
49465	2002	5	1	31.0
49465	2002	5	2	0.0
49465	2002	5	3	0.0
49465	2002	5	4	0.0
49465	2002	5	5	0.0
49465	2002	5	6	0.0
49465	2002	5	7	0.0
49465	2002	5	8	0.0
49465	2002	5	9	0.0
49465	2002	5	10	0.0
49465	2002	5	11	36.2

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2002	5	12	0.0
49465	2002	5	13	0.0
49465	2002	5	14	0.0
49465	2002	5	15	0.0
49465	2002	5	16	1.5
49465	2002	5	17	0.0
49465	2002	5	18	0.0
49465	2002	5	19	0.0
49465	2002	5	20	0.0
49465	2002	5	21	10.0
49465	2002	5	22	11.8
49465	2002	5	23	18.2
49465	2002	5	24	19.0
49465	2002	5	25	0.0
49465	2002	5	26	0.0
49465	2002	5	27	0.0
49465	2002	5	28	0.0
49465	2002	5	29	0.0
49465	2002	5	30	0.0
49465	2002	5	31	0.0
49465	2002	6	1	0.0
49465	2002	6	2	24.5
49465	2002	6	3	0.0
49465	2002	6	4	0.0
49465	2002	6	5	0.0
49465	2002	6	6	0.0
49465	2002	6	7	0.0
49465	2002	6	8	0.0
49465	2002	6	9	0.0
49465	2002	6	10	0.0
49465	2002	6	11	0.0
49465	2002	6	12	0.0
49465	2002	6	13	0.0
49465	2002	6	14	0.0
49465	2002	6	15	21.5
49465	2002	6	16	24.5
49465	2002	6	17	0.0
49465	2002	6	18	0.0
49465	2002	6	19	0.0
49465	2002	6	20	0.0
49465	2002	6	21	0.0
49465	2002	6	22	0.0
49465	2002	6	23	0.0
49465	2002	6	24	0.0
49465	2002	6	25	45.0
49465	2002	6	26	0.0
49465	2002	6	27	0.0
49465	2002	6	28	0.0
49465	2002	6	29	1.0
49465	2002	6	30	0.0
49465	2002	7	1	0.0
49465	2002	7	2	0.0
49465	2002	7	3	0.0
49465	2002	7	4	0.0
49465	2002	7	5	0.0
49465	2002	7	6	0.0

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2002	7	7	0.0
49465	2002	7	8	0.0
49465	2002	7	9	0.0
49465	2002	7	10	30.0
49465	2002	7	11	0.0
49465	2002	7	12	0.0
49465	2002	7	13	0.0
49465	2002	7	14	0.0
49465	2002	7	15	0.0
49465	2002	7	16	0.0
49465	2002	7	17	0.0
49465	2002	7	18	0.0
49465	2002	7	19	0.0
49465	2002	7	20	0.0
49465	2002	7	21	0.0
49465	2002	7	22	0.0
49465	2002	7	23	0.0
49465	2002	7	24	0.0
49465	2002	7	25	0.0
49465	2002	7	26	0.0
49465	2002	7	27	0.0
49465	2002	7	28	68.3
49465	2002	7	29	0.0
49465	2002	7	30	0.0
49465	2002	7	31	0.0
49465	2002	8	1	0.0
49465	2002	8	2	46.8
49465	2002	8	3	7.5
49465	2002	8	4	0.0
49465	2002	8	5	0.0
49465	2002	8	6	0.0
49465	2002	8	7	12.2
49465	2002	8	8	0.0
49465	2002	8	9	0.0
49465	2002	8	10	0.0
49465	2002	8	11	0.0
49465	2002	8	12	0.0
49465	2002	8	13	0.0
49465	2002	8	14	0.0
49465	2002	8	15	0.0
49465	2002	8	16	0.0
49465	2002	8	17	11.0
49465	2002	8	18	0.0
49465	2002	8	19	0.0
49465	2002	8	20	0.0
49465	2002	8	21	4.5
49465	2002	8	22	0.0
49465	2002	8	23	0.8
49465	2002	8	24	0.0
49465	2002	8	25	0.0
49465	2002	8	26	3.0
49465	2002	8	27	9.0
49465	2002	8	28	0.0
49465	2002	8	29	0.0
49465	2002	8	30	17.6
49465	2002	8	31	0.0

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2002	9	1	22.0
49465	2002	9	2	0.0
49465	2002	9	3	0.0
49465	2002	9	4	0.0
49465	2002	9	5	0.0
49465	2002	9	6	3.0
49465	2002	9	7	22.5
49465	2002	9	8	0.0
49465	2002	9	9	24.0
49465	2002	9	10	0.0
49465	2002	9	11	0.0
49465	2002	9	12	10.0
49465	2002	9	13	0.0
49465	2002	9	14	0.0
49465	2002	9	15	0.0
49465	2002	9	16	0.0
49465	2002	9	17	0.0
49465	2002	9	18	0.0
49465	2002	9	19	0.0
49465	2002	9	20	0.0
49465	2002	9	21	0.0
49465	2002	9	22	0.0
49465	2002	9	23	0.0
49465	2002	9	24	60.0
49465	2002	9	25	55.0
49465	2002	9	26	0.0
49465	2002	9	27	0.0
49465	2002	9	28	0.0
49465	2002	9	29	0.0
49465	2002	9	30	0.0
49465	2002	10	1	0.0
49465	2002	10	2	0.0
49465	2002	10	3	0.0
49465	2002	10	4	0.0
49465	2002	10	5	0.0
49465	2002	10	6	0.0
49465	2002	10	7	0.0
49465	2002	10	8	0.0
49465	2002	10	9	0.0
49465	2002	10	10	0.0
49465	2002	10	11	90.0
49465	2002	10	12	25.4
49465	2002	10	13	0.0
49465	2002	10	14	0.0
49465	2002	10	15	1.3
49465	2002	10	16	0.0
49465	2002	10	17	0.0
49465	2002	10	18	0.0
49465	2002	10	19	3.0
49465	2002	10	20	0.0
49465	2002	10	21	0.0
49465	2002	10	22	24.4
49465	2002	10	23	0.0
49465	2002	10	24	0.0
49465	2002	10	25	0.0
49465	2002	10	26	0.0

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2002	10	27	26.2
49465	2002	10	28	0.0
49465	2002	10	29	0.0
49465	2002	10	30	23.5
49465	2002	10	31	0.0
49465	2002	11	1	7.0
49465	2002	11	2	2.4
49465	2002	11	3	1.6
49465	2002	11	4	0.0
49465	2002	11	5	0.0
49465	2002	11	6	0.0
49465	2002	11	7	0.0
49465	2002	11	8	0.0
49465	2002	11	9	0.0
49465	2002	11	10	0.0
49465	2002	11	11	0.0
49465	2002	11	12	0.0
49465	2002	11	13	28.2
49465	2002	11	14	40.0
49465	2002	11	15	0.0
49465	2002	11	16	0.0
49465	2002	11	17	26.4
49465	2002	11	18	0.0
49465	2002	11	19	36.2
49465	2002	11	20	31.4
49465	2002	11	21	0.0
49465	2002	11	22	48.2
49465	2002	11	23	46.4
49465	2002	11	24	18.4
49465	2002	11	25	0.0
49465	2002	11	26	-33.3
49465	2002	11	27	0.0
49465	2002	11	28	0.0
49465	2002	11	29	0.0
49465	2002	11	30	0.0
49465	2002	12	1	7.5
49465	2002	12	2	4.5
49465	2002	12	3	0.0
49465	2002	12	4	0.0
49465	2002	12	5	0.0
49465	2002	12	6	0.0
49465	2002	12	7	0.0
49465	2002	12	8	24.2
49465	2002	12	9	14.2
49465	2002	12	10	34.0
49465	2002	12	11	6.4
49465	2002	12	12	12.0
49465	2002	12	13	90.0
49465	2002	12	14	30.8
49465	2002	12	15	40.4
49465	2002	12	16	0.0
49465	2002	12	17	0.0
49465	2002	12	18	0.0
49465	2002	12	19	0.0
49465	2002	12	20	0.0
49465	2002	12	21	1.2

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2002	12	22	12.0
49465	2002	12	23	2.5
49465	2002	12	24	0.0
49465	2002	12	25	17.0
49465	2002	12	26	160.3
49465	2002	12	27	3.0
49465	2002	12	28	2.0
49465	2002	12	29	56.4
49465	2002	12	30	0.0
49465	2002	12	31	0.0
49465	2003	1	1	68.2
49465	2003	1	2	70.3
49465	2003	1	3	30.8
49465	2003	1	4	36.8
49465	2003	1	5	0.0
49465	2003	1	6	38.2
49465	2003	1	7	0.0
49465	2003	1	8	0.0
49465	2003	1	9	0.0
49465	2003	1	10	0.0
49465	2003	1	11	0.0
49465	2003	1	12	40.3
49465	2003	1	13	0.0
49465	2003	1	14	0.0
49465	2003	1	15	0.0
49465	2003	1	16	0.0
49465	2003	1	17	0.0
49465	2003	1	18	0.0
49465	2003	1	19	0.0
49465	2003	1	20	0.0
49465	2003	1	21	6.0
49465	2003	1	22	4.5
49465	2003	1	23	9.5
49465	2003	1	24	16.0
49465	2003	1	25	6.5
49465	2003	1	26	0.0
49465	2003	1	27	0.0
49465	2003	1	28	0.0
49465	2003	1	29	6.7
49465	2003	1	30	0.0
49465	2003	1	31	0.0
49465	2003	2	1	0.0
49465	2003	2	2	0.0
49465	2003	2	3	0.0
49465	2003	2	4	0.0
49465	2003	2	5	0.0
49465	2003	2	6	7.0
49465	2003	2	7	8.0
49465	2003	2	8	23.5
49465	2003	2	9	10.5
49465	2003	2	10	50.8
49465	2003	2	11	3.0
49465	2003	2	12	0.0
49465	2003	2	13	0.0
49465	2003	2	14	42.4
49465	2003	2	15	0.0

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2003	2	16	0.0
49465	2003	2	17	0.0
49465	2003	2	18	0.0
49465	2003	2	19	0.0
49465	2003	2	20	0.0
49465	2003	2	21	0.0
49465	2003	2	22	0.0
49465	2003	2	23	0.0
49465	2003	2	24	0.0
49465	2003	2	25	0.0
49465	2003	2	26	0.0
49465	2003	2	27	0.0
49465	2003	2	28	0.0
49465	2003	3	1	8.4
49465	2003	3	2	6.0
49465	2003	3	3	0.0
49465	2003	3	4	0.0
49465	2003	3	5	0.0
49465	2003	3	6	0.0
49465	2003	3	7	0.0
49465	2003	3	8	0.0
49465	2003	3	9	0.0
49465	2003	3	10	0.0
49465	2003	3	11	0.0
49465	2003	3	12	0.0
49465	2003	3	13	0.0
49465	2003	3	14	0.0
49465	2003	3	15	21.2
49465	2003	3	16	10.0
49465	2003	3	17	0.0
49465	2003	3	18	0.0
49465	2003	3	19	0.0
49465	2003	3	20	0.0
49465	2003	3	21	0.0
49465	2003	3	22	21.8
49465	2003	3	23	41.2
49465	2003	3	24	35.2
49465	2003	3	25	30.8
49465	2003	3	26	32.2
49465	2003	3	27	21.6
49465	2003	3	28	0.0
49465	2003	3	29	0.0
49465	2003	3	30	0.0
49465	2003	3	31	0.0
49465	2003	4	1	12.0
49465	2003	4	2	0.0
49465	2003	4	3	0.0
49465	2003	4	4	0.0
49465	2003	4	5	0.0
49465	2003	4	6	0.0
49465	2003	4	7	7.8
49465	2003	4	8	0.0
49465	2003	4	9	45.6
49465	2003	4	10	0.0
49465	2003	4	11	0.0
49465	2003	4	12	14.3

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2003	4	13	0.0
49465	2003	4	14	0.0
49465	2003	4	15	0.0
49465	2003	4	16	21.0
49465	2003	4	17	0.0
49465	2003	4	18	0.0
49465	2003	4	19	0.0
49465	2003	4	20	0.0
49465	2003	4	21	0.0
49465	2003	4	22	0.0
49465	2003	4	23	0.0
49465	2003	4	24	0.0
49465	2003	4	25	4.8
49465	2003	4	26	0.0
49465	2003	4	27	0.0
49465	2003	4	28	0.0
49465	2003	4	29	0.0
49465	2003	4	30	34.0
49465	2003	5	1	0.0
49465	2003	5	2	0.0
49465	2003	5	3	0.0
49465	2003	5	4	0.0
49465	2003	5	5	18.2
49465	2003	5	6	0.0
49465	2003	5	7	30.8
49465	2003	5	8	0.0
49465	2003	5	9	0.0
49465	2003	5	10	0.0
49465	2003	5	11	34.2
49465	2003	5	12	0.0
49465	2003	5	13	0.0
49465	2003	5	14	0.0
49465	2003	5	15	0.0
49465	2003	5	16	7.5
49465	2003	5	17	0.0
49465	2003	5	18	0.0
49465	2003	5	19	0.0
49465	2003	5	20	18.2
49465	2003	5	21	0.0
49465	2003	5	22	0.0
49465	2003	5	23	0.0
49465	2003	5	24	9.0
49465	2003	5	25	0.0
49465	2003	5	26	0.0
49465	2003	5	27	0.0
49465	2003	5	28	0.0
49465	2003	5	29	0.0
49465	2003	5	30	0.0
49465	2003	5	31	0.0
49465	2003	6	1	0.0
49465	2003	6	2	0.0
49465	2003	6	3	0.0
49465	2003	6	4	0.0
49465	2003	6	5	0.0
49465	2003	6	6	6.4
49465	2003	6	7	0.0

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2003	6	8	0.0
49465	2003	6	9	0.0
49465	2003	6	10	0.0
49465	2003	6	11	5.0
49465	2003	6	12	0.0
49465	2003	6	13	13.0
49465	2003	6	14	1.5
49465	2003	6	15	0.0
49465	2003	6	16	0.0
49465	2003	6	17	0.0
49465	2003	6	18	0.0
49465	2003	6	19	0.0
49465	2003	6	20	10.4
49465	2003	6	21	0.0
49465	2003	6	22	0.0
49465	2003	6	23	0.0
49465	2003	6	24	0.0
49465	2003	6	25	0.0
49465	2003	6	26	0.0
49465	2003	6	27	0.0
49465	2003	6	28	0.0
49465	2003	6	29	23.7
49465	2003	6	30	0.0
49465	2003	7	1	26.4
49465	2003	7	2	0.0
49465	2003	7	3	16.5
49465	2003	7	4	30.0
49465	2003	7	5	0.0
49465	2003	7	6	0.0
49465	2003	7	7	0.0
49465	2003	7	8	0.0
49465	2003	7	9	0.0
49465	2003	7	10	0.0
49465	2003	7	11	6.0
49465	2003	7	12	0.0
49465	2003	7	13	0.0
49465	2003	7	14	0.0
49465	2003	7	15	0.0
49465	2003	7	16	0.0
49465	2003	7	17	22.0
49465	2003	7	18	40.4
49465	2003	7	19	14.5
49465	2003	7	20	0.0
49465	2003	7	21	0.0
49465	2003	7	22	0.0
49465	2003	7	23	0.0
49465	2003	7	24	0.0
49465	2003	7	25	0.0
49465	2003	7	26	0.0
49465	2003	7	27	0.0
49465	2003	7	28	0.0
49465	2003	7	29	0.0
49465	2003	7	30	0.0
49465	2003	7	31	0.0
49465	2003	8	1	0.0
49465	2003	8	2	0.0

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2003	8	3	0.0
49465	2003	8	4	0.0
49465	2003	8	5	0.0
49465	2003	8	6	0.0
49465	2003	8	7	0.0
49465	2003	8	8	0.0
49465	2003	8	9	0.0
49465	2003	8	10	68.2
49465	2003	8	11	0.0
49465	2003	8	12	0.0
49465	2003	8	13	16.5
49465	2003	8	14	0.0
49465	2003	8	15	0.0
49465	2003	8	16	90.8
49465	2003	8	17	0.0
49465	2003	8	18	0.0
49465	2003	8	19	20.2
49465	2003	8	20	0.0
49465	2003	8	21	0.0
49465	2003	8	22	0.0
49465	2003	8	23	0.0
49465	2003	8	24	0.0
49465	2003	8	25	0.0
49465	2003	8	26	0.0
49465	2003	8	27	0.0
49465	2003	8	28	0.0
49465	2003	8	29	0.0
49465	2003	8	30	0.0
49465	2003	8	31	0.0
49465	2003	9	1	41.2
49465	2003	9	2	14.8
49465	2003	9	3	0.0
49465	2003	9	4	0.0
49465	2003	9	5	0.0
49465	2003	9	6	0.0
49465	2003	9	7	0.0
49465	2003	9	8	0.0
49465	2003	9	9	0.0
49465	2003	9	10	35.8
49465	2003	9	11	0.0
49465	2003	9	12	0.0
49465	2003	9	13	25.8
49465	2003	9	14	21.8
49465	2003	9	15	0.0
49465	2003	9	16	0.0
49465	2003	9	17	0.0
49465	2003	9	18	0.0
49465	2003	9	19	0.0
49465	2003	9	20	0.0
49465	2003	9	21	0.0
49465	2003	9	22	0.0
49465	2003	9	23	0.0
49465	2003	9	24	0.0
49465	2003	9	25	0.0
49465	2003	9	26	0.0
49465	2003	9	27	0.0

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2003	9	28	0.0
49465	2003	9	29	0.0
49465	2003	9	30	0.0
49465	2003	10	1	0.0
49465	2003	10	2	0.0
49465	2003	10	3	46.0
49465	2003	10	4	0.0
49465	2003	10	5	0.0
49465	2003	10	6	0.0
49465	2003	10	7	0.0
49465	2003	10	8	0.0
49465	2003	10	9	0.0
49465	2003	10	10	38.8
49465	2003	10	11	17.5
49465	2003	10	12	0.0
49465	2003	10	13	0.0
49465	2003	10	14	12.4
49465	2003	10	15	0.0
49465	2003	10	16	0.0
49465	2003	10	17	0.0
49465	2003	10	18	0.0
49465	2003	10	19	38.2
49465	2003	10	20	0.0
49465	2003	10	21	0.0
49465	2003	10	22	0.0
49465	2003	10	23	0.0
49465	2003	10	24	0.0
49465	2003	10	25	0.0
49465	2003	10	26	0.0
49465	2003	10	27	0.0
49465	2003	10	28	80.3
49465	2003	10	29	1.0
49465	2003	10	30	0.0
49465	2003	10	31	0.0
49465	2003	11	1	0.0
49465	2003	11	2	0.0
49465	2003	11	3	0.0
49465	2003	11	4	22.3
49465	2003	11	5	46.6
49465	2003	11	6	0.0
49465	2003	11	7	0.0
49465	2003	11	8	1.8
49465	2003	11	9	0.0
49465	2003	11	10	0.0
49465	2003	11	11	0.0
49465	2003	11	12	0.0
49465	2003	11	13	0.0
49465	2003	11	14	0.0
49465	2003	11	15	0.0
49465	2003	11	16	0.0
49465	2003	11	17	0.0
49465	2003	11	18	0.0
49465	2003	11	19	0.0
49465	2003	11	20	0.0
49465	2003	11	21	0.0
49465	2003	11	22	0.0

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2003	11	23	0.0
49465	2003	11	24	45.0
49465	2003	11	25	40.0
49465	2003	11	26	36.2
49465	2003	11	27	45.6
49465	2003	11	28	40.6
49465	2003	11	29	120.0
49465	2003	11	30	80.0
49465	2003	12	1	184.0
49465	2003	12	2	0.0
49465	2003	12	3	68.5
49465	2003	12	4	0.0
49465	2003	12	5	0.0
49465	2003	12	6	21.4
49465	2003	12	7	40.2
49465	2003	12	8	68.4
49465	2003	12	9	0.0
49465	2003	12	10	86.4
49465	2003	12	11	30.4
49465	2003	12	12	62.4
49465	2003	12	13	0.0
49465	2003	12	14	0.0
49465	2003	12	15	0.0
49465	2003	12	16	0.0
49465	2003	12	17	0.0
49465	2003	12	18	0.0
49465	2003	12	19	16.0
49465	2003	12	20	32.7
49465	2003	12	21	0.0
49465	2003	12	22	0.0
49465	2003	12	23	0.0
49465	2003	12	24	0.0
49465	2003	12	25	0.0
49465	2003	12	26	0.0
49465	2003	12	27	0.0
49465	2003	12	28	0.0
49465	2003	12	29	0.0
49465	2003	12	30	13.8
49465	2003	12	31	0.0
49465	2004	1	1	0.0
49465	2004	1	2	0.0
49465	2004	1	3	0.0
49465	2004	1	4	0.0
49465	2004	1	5	0.0
49465	2004	1	6	0.0
49465	2004	1	7	0.0
49465	2004	1	8	0.0
49465	2004	1	9	0.0
49465	2004	1	10	0.0
49465	2004	1	11	0.0
49465	2004	1	12	0.0
49465	2004	1	13	0.0
49465	2004	1	14	0.0
49465	2004	1	15	0.0
49465	2004	1	16	0.0
49465	2004	1	17	0.0

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2004	1	18	21.0
49465	2004	1	19	0.0
49465	2004	1	20	0.0
49465	2004	1	21	0.0
49465	2004	1	22	0.0
49465	2004	1	23	0.0
49465	2004	1	24	0.0
49465	2004	1	25	0.0
49465	2004	1	26	0.0
49465	2004	1	27	0.0
49465	2004	1	28	0.0
49465	2004	1	29	0.0
49465	2004	1	30	0.0
49465	2004	1	31	0.0
49465	2004	2	1	0.0
49465	2004	2	2	0.0
49465	2004	2	3	0.0
49465	2004	2	4	0.0
49465	2004	2	5	0.0
49465	2004	2	6	26.5
49465	2004	2	7	0.0
49465	2004	2	8	0.0
49465	2004	2	9	0.0
49465	2004	2	10	0.0
49465	2004	2	11	0.0
49465	2004	2	12	0.0
49465	2004	2	13	0.0
49465	2004	2	14	0.0
49465	2004	2	15	0.0
49465	2004	2	16	0.0
49465	2004	2	17	0.0
49465	2004	2	18	0.0
49465	2004	2	19	0.0
49465	2004	2	20	0.0
49465	2004	2	21	0.0
49465	2004	2	22	0.0
49465	2004	2	23	0.0
49465	2004	2	24	0.0
49465	2004	2	25	0.0
49465	2004	2	26	0.0
49465	2004	2	27	0.0
49465	2004	2	28	10.6
49465	2004	2	29	0.0
49465	2004	3	1	0.0
49465	2004	3	2	0.0
49465	2004	3	3	0.0
49465	2004	3	4	0.0
49465	2004	3	5	0.0
49465	2004	3	6	0.0
49465	2004	3	7	0.0
49465	2004	3	8	26.2
49465	2004	3	9	0.6
49465	2004	3	10	0.0
49465	2004	3	11	0.0
49465	2004	3	12	0.0
49465	2004	3	13	0.0

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2004	3	14	0.0
49465	2004	3	15	0.0
49465	2004	3	16	0.0
49465	2004	3	17	0.0
49465	2004	3	18	0.0
49465	2004	3	19	0.0
49465	2004	3	20	0.0
49465	2004	3	21	0.0
49465	2004	3	22	0.0
49465	2004	3	23	0.0
49465	2004	3	24	0.0
49465	2004	3	25	0.0
49465	2004	3	26	0.0
49465	2004	3	27	0.0
49465	2004	3	28	0.0
49465	2004	3	29	0.0
49465	2004	3	30	0.0
49465	2004	3	31	0.0
49465	2004	4	1	0.0
49465	2004	4	2	0.0
49465	2004	4	3	0.0
49465	2004	4	4	0.0
49465	2004	4	5	0.0
49465	2004	4	6	0.0
49465	2004	4	7	0.0
49465	2004	4	8	0.0
49465	2004	4	9	0.0
49465	2004	4	10	0.0
49465	2004	4	11	0.0
49465	2004	4	12	0.0
49465	2004	4	13	0.0
49465	2004	4	14	0.0
49465	2004	4	15	0.0
49465	2004	4	16	0.0
49465	2004	4	17	0.0
49465	2004	4	18	0.0
49465	2004	4	19	0.0
49465	2004	4	20	0.0
49465	2004	4	21	0.0
49465	2004	4	22	0.0
49465	2004	4	23	0.0
49465	2004	4	24	0.0
49465	2004	4	25	0.0
49465	2004	4	26	0.0
49465	2004	4	27	0.0
49465	2004	4	28	21.2
49465	2004	4	29	0.0
49465	2004	4	30	0.0
49465	2004	5	1	4.8
49465	2004	5	2	0.0
49465	2004	5	3	0.0
49465	2004	5	4	0.0
49465	2004	5	5	0.0
49465	2004	5	6	0.0
49465	2004	5	7	0.0
49465	2004	5	8	0.0

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2004	5	9	0.0
49465	2004	5	10	0.0
49465	2004	5	11	0.0
49465	2004	5	12	0.0
49465	2004	5	13	0.0
49465	2004	5	14	0.0
49465	2004	5	15	20.0
49465	2004	5	16	17.0
49465	2004	5	17	0.0
49465	2004	5	18	0.0
49465	2004	5	19	0.0
49465	2004	5	20	0.0
49465	2004	5	21	0.0
49465	2004	5	22	0.0
49465	2004	5	23	35.6
49465	2004	5	24	0.0
49465	2004	5	25	0.0
49465	2004	5	26	0.0
49465	2004	5	27	0.0
49465	2004	5	28	0.0
49465	2004	5	29	0.0
49465	2004	5	30	0.0
49465	2004	5	31	0.0
49465	2004	6	1	0.0
49465	2004	6	2	0.0
49465	2004	6	3	0.0
49465	2004	6	4	0.0
49465	2004	6	5	0.0
49465	2004	6	6	42.4
49465	2004	6	7	0.0
49465	2004	6	8	21.5
49465	2004	6	9	0.0
49465	2004	6	10	0.0
49465	2004	6	11	0.0
49465	2004	6	12	0.0
49465	2004	6	13	0.0
49465	2004	6	14	0.0
49465	2004	6	15	0.0
49465	2004	6	16	0.0
49465	2004	6	17	0.0
49465	2004	6	18	0.0
49465	2004	6	19	0.0
49465	2004	6	20	0.0
49465	2004	6	21	20.8
49465	2004	6	22	0.0
49465	2004	6	23	40.8
49465	2004	6	24	42.2
49465	2004	6	25	0.0
49465	2004	6	26	0.0
49465	2004	6	27	0.0
49465	2004	6	28	0.0
49465	2004	6	29	6.0
49465	2004	6	30	0.0
49465	2004	7	1	0.0
49465	2004	7	2	0.0
49465	2004	7	3	0.0

Stnno	Year	Month	Day	Rainfall (06-06 MST) (mm)
49465	2004	7	4	0.0
49465	2004	7	5	0.0
49465	2004	7	6	0.0
49465	2004	7	7	0.0
49465	2004	7	8	0.0
49465	2004	7	9	0.0
49465	2004	7	10	0.0
49465	2004	7	11	68.2
49465	2004	7	12	0.0
49465	2004	7	13	0.0
49465	2004	7	14	0.0
49465	2004	7	15	0.0
49465	2004	7	16	0.0
49465	2004	7	17	0.0
49465	2004	7	18	0.0
49465	2004	7	19	0.0
49465	2004	7	20	0.0
49465	2004	7	21	0.0
49465	2004	7	22	0.0
49465	2004	7	23	0.0
49465	2004	7	24	0.0
49465	2004	7	25	0.0
49465	2004	7	26	0.0
49465	2004	7	27	0.0
49465	2004	7	28	0.0
49465	2004	7	29	0.0
49465	2004	7	30	0.0
49465	2004	7	31	0.0
49465	2004	8	1	5.2
49465	2004	8	2	0.0
49465	2004	8	3	0.0
49465	2004	8	4	3.4
49465	2004	8	5	0.0
49465	2004	8	6	0.0
49465	2004	8	7	0.0
49465	2004	8	8	0.0
49465	2004	8	9	0.0
49465	2004	8	10	4.5
49465	2004	8	11	0.0
49465	2004	8	12	0.0
49465	2004	8	13	42.2
49465	2004	8	14	0.0
49465	2004	8	15	25.6
49465	2004	8	16	0.0
49465	2004	8	17	0.0
49465	2004	8	18	0.0
49465	2004	8	19	0.0
49465	2004	8	20	0.0
49465	2004	8	21	0.0
49465	2004	8	22	15.3
49465	2004	8	23	0.0
49465	2004	8	24	2.0
49465	2004	8	25	0.0
49465	2004	8	26	0.0
49465	2004	8	27	0.0
49465	2004	8	28	0.0

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2004	8	29	0.0
49465	2004	8	30	0.0
49465	2004	8	31	0.0
49465	2004	9	1	0.0
49465	2004	9	2	0.0
49465	2004	9	3	0.0
49465	2004	9	4	0.0
49465	2004	9	5	0.0
49465	2004	9	6	0.0
49465	2004	9	7	0.0
49465	2004	9	8	0.0
49465	2004	9	9	0.0
49465	2004	9	10	0.0
49465	2004	9	11	0.0
49465	2004	9	12	0.0
49465	2004	9	13	0.0
49465	2004	9	14	0.0
49465	2004	9	15	0.0
49465	2004	9	16	0.0
49465	2004	9	17	0.0
49465	2004	9	18	15.0
49465	2004	9	19	0.0
49465	2004	9	20	0.0
49465	2004	9	21	0.0
49465	2004	9	22	0.0
49465	2004	9	23	0.0
49465	2004	9	24	0.0
49465	2004	9	25	0.0
49465	2004	9	26	0.0
49465	2004	9	27	0.0
49465	2004	9	28	0.0
49465	2004	9	29	0.0
49465	2004	9	30	0.0
49465	2004	10	1	18.6
49465	2004	10	2	0.0
49465	2004	10	3	0.0
49465	2004	10	4	0.0
49465	2004	10	5	0.0
49465	2004	10	6	0.0
49465	2004	10	7	0.0
49465	2004	10	8	28.6
49465	2004	10	9	0.0
49465	2004	10	10	0.0
49465	2004	10	11	0.0
49465	2004	10	12	0.0
49465	2004	10	13	0.0
49465	2004	10	14	0.0
49465	2004	10	15	0.0
49465	2004	10	16	0.0
49465	2004	10	17	0.0
49465	2004	10	18	67.5
49465	2004	10	19	0.0
49465	2004	10	20	0.0
49465	2004	10	21	86.0
49465	2004	10	22	0.0
49465	2004	10	23	37.5

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2004	10	24	45.0
49465	2004	10	25	57.2
49465	2004	10	26	54.5
49465	2004	10	27	62.6
49465	2004	10	28	66.4
49465	2004	10	29	57.2
49465	2004	10	30	126.0
49465	2004	10	31	0.0
49465	2004	11	1	5.4
49465	2004	11	2	22.4
49465	2004	11	3	16.8
49465	2004	11	4	28.6
49465	2004	11	5	38.0
49465	2004	11	6	0.0
49465	2004	11	7	0.0
49465	2004	11	8	0.0
49465	2004	11	9	0.0
49465	2004	11	10	55.0
49465	2004	11	11	46.6
49465	2004	11	12	47.8
49465	2004	11	13	14.0
49465	2004	11	14	22.0
49465	2004	11	15	18.8
49465	2004	11	16	7.2
49465	2004	11	17	0.0
49465	2004	11	18	0.0
49465	2004	11	19	0.0
49465	2004	11	20	0.0
49465	2004	11	21	0.0
49465	2004	11	22	0.0
49465	2004	11	23	0.0
49465	2004	11	24	0.0
49465	2004	11	25	0.0
49465	2004	11	26	0.0
49465	2004	11	27	92.0
49465	2004	11	28	0.0
49465	2004	11	29	0.0
49465	2004	11	30	0.0
49465	2004	12	1	0.0
49465	2004	12	2	0.0
49465	2004	12	3	0.0
49465	2004	12	4	0.0
49465	2004	12	5	0.0
49465	2004	12	6	50.8
49465	2004	12	7	80.4
49465	2004	12	8	74.4
49465	2004	12	9	82.4
49465	2004	12	10	90.6
49465	2004	12	11	0.0
49465	2004	12	12	0.0
49465	2004	12	13	0.0
49465	2004	12	14	0.0
49465	2004	12	15	0.0
49465	2004	12	16	0.0
49465	2004	12	17	0.0
49465	2004	12	18	0.0

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2004	12	19	0.0
49465	2004	12	20	8.8
49465	2004	12	21	12.4
49465	2004	12	22	32.4
49465	2004	12	23	18.6
49465	2004	12	24	20.4
49465	2004	12	25	44.5
49465	2004	12	26	27.5
49465	2004	12	27	0.0
49465	2004	12	28	0.0
49465	2004	12	29	0.0
49465	2004	12	30	0.0
49465	2004	12	31	5.0
49465	2005	1	1	0.0
49465	2005	1	2	0.0
49465	2005	1	3	0.0
49465	2005	1	4	0.0
49465	2005	1	5	0.0
49465	2005	1	6	0.0
49465	2005	1	7	0.0
49465	2005	1	8	115.7
49465	2005	1	9	0.0
49465	2005	1	10	0.0
49465	2005	1	11	1.7
49465	2005	1	12	0.0
49465	2005	1	13	0.0
49465	2005	1	14	0.0
49465	2005	1	15	0.0
49465	2005	1	16	0.0
49465	2005	1	17	0.0
49465	2005	1	18	0.0
49465	2005	1	19	0.0
49465	2005	1	20	0.0
49465	2005	1	21	0.0
49465	2005	1	22	0.0
49465	2005	1	23	11.3
49465	2005	1	24	0.0
49465	2005	1	25	0.0
49465	2005	1	26	0.0
49465	2005	1	27	0.0
49465	2005	1	28	0.0
49465	2005	1	29	0.0
49465	2005	1	30	0.0
49465	2005	1	31	0.0
49465	2005	2	1	0.0
49465	2005	2	2	0.0
49465	2005	2	3	0.0
49465	2005	2	4	0.0
49465	2005	2	5	0.0
49465	2005	2	6	0.0
49465	2005	2	7	0.0
49465	2005	2	8	0.0
49465	2005	2	9	0.0
49465	2005	2	10	0.0
49465	2005	2	11	0.0
49465	2005	2	12	0.0

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2005	2	13	8.8
49465	2005	2	14	0.0
49465	2005	2	15	0.0
49465	2005	2	16	0.0
49465	2005	2	17	0.0
49465	2005	2	18	0.0
49465	2005	2	19	0.0
49465	2005	2	20	0.0
49465	2005	2	21	0.0
49465	2005	2	22	0.0
49465	2005	2	23	0.0
49465	2005	2	24	0.0
49465	2005	2	25	0.0
49465	2005	2	26	0.0
49465	2005	2	27	0.0
49465	2005	2	28	0.0
49465	2005	3	1	0.0
49465	2005	3	2	0.0
49465	2005	3	3	0.0
49465	2005	3	4	3.8
49465	2005	3	5	15.2
49465	2005	3	6	1.4
49465	2005	3	7	0.0
49465	2005	3	8	0.0
49465	2005	3	9	0.0
49465	2005	3	10	0.0
49465	2005	3	11	0.0
49465	2005	3	12	0.0
49465	2005	3	13	0.0
49465	2005	3	14	0.0
49465	2005	3	15	0.0
49465	2005	3	16	8.3
49465	2005	3	17	0.0
49465	2005	3	18	0.0
49465	2005	3	19	0.0
49465	2005	3	20	0.0
49465	2005	3	21	0.0
49465	2005	3	22	0.0
49465	2005	3	23	0.0
49465	2005	3	24	0.0
49465	2005	3	25	0.0
49465	2005	3	26	0.0
49465	2005	3	27	24.8
49465	2005	3	28	0.0
49465	2005	3	29	0.0
49465	2005	3	30	2.4
49465	2005	3	31	0.0
49465	2005	4	1	0.0
49465	2005	4	2	12.5
49465	2005	4	3	0.0
49465	2005	4	4	13.5
49465	2005	4	5	95.6
49465	2005	4	6	0.0
49465	2005	4	7	0.0
49465	2005	4	8	0.0
49465	2005	4	9	0.0

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2005	6	5	0.0
49465	2005	6	6	0.0
49465	2005	6	7	42.6
49465	2005	6	8	0.0
49465	2005	6	9	0.0
49465	2005	6	10	0.0
49465	2005	6	11	0.0
49465	2005	6	12	0.0
49465	2005	6	13	0.0
49465	2005	6	14	0.0
49465	2005	6	15	0.0
49465	2005	6	16	0.0
49465	2005	6	17	0.0
49465	2005	6	18	0.0
49465	2005	6	19	11.5
49465	2005	6	20	0.0
49465	2005	6	21	0.0
49465	2005	6	22	0.0
49465	2005	6	23	0.0
49465	2005	6	24	0.0
49465	2005	6	25	0.0
49465	2005	6	26	0.0
49465	2005	6	27	0.0
49465	2005	6	28	0.0
49465	2005	6	29	0.0
49465	2005	6	30	0.0
49465	2005	7	1	0.0
49465	2005	7	2	0.0
49465	2005	7	3	0.0
49465	2005	7	4	0.0
49465	2005	7	5	32.0
49465	2005	7	6	0.0
49465	2005	7	7	0.0
49465	2005	7	8	0.0
49465	2005	7	9	0.0
49465	2005	7	10	0.0
49465	2005	7	11	0.0
49465	2005	7	12	0.0
49465	2005	7	13	0.0
49465	2005	7	14	0.0
49465	2005	7	15	0.0
49465	2005	7	16	0.0
49465	2005	7	17	0.0
49465	2005	7	18	0.0
49465	2005	7	19	0.0
49465	2005	7	20	0.0
49465	2005	7	21	0.0
49465	2005	7	22	0.0
49465	2005	7	23	0.0
49465	2005	7	24	0.0
49465	2005	7	25	0.0
49465	2005	7	26	10.5
49465	2005	7	27	15.5
49465	2005	7	28	0.0
49465	2005	7	29	6.0
49465	2005	7	30	0.0

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2005	7	31	0.0
49465	2005	8	1	0.0
49465	2005	8	2	0.0
49465	2005	8	3	0.0
49465	2005	8	4	0.2
49465	2005	8	5	0.0
49465	2005	8	6	0.0
49465	2005	8	7	0.0
49465	2005	8	8	0.2
49465	2005	8	9	39.2
49465	2005	8	10	0.0
49465	2005	8	11	0.0
49465	2005	8	12	0.0
49465	2005	8	13	0.0
49465	2005	8	14	0.0
49465	2005	8	15	0.0
49465	2005	8	16	0.0
49465	2005	8	17	0.0
49465	2005	8	18	7.4
49465	2005	8	19	0.0
49465	2005	8	20	0.0
49465	2005	8	21	0.0
49465	2005	8	22	23.8
49465	2005	8	23	3.8
49465	2005	8	24	0.0
49465	2005	8	25	0.0
49465	2005	8	26	0.0
49465	2005	8	27	6.6
49465	2005	8	28	0.0
49465	2005	8	29	7.0
49465	2005	8	30	0.0
49465	2005	8	31	4.0
49465	2005	9	1	1.2
49465	2005	9	2	0.0
49465	2005	9	3	11.0
49465	2005	9	4	0.2
49465	2005	9	5	1.2
49465	2005	9	6	0.2
49465	2005	9	7	14.6
49465	2005	9	8	0.2
49465	2005	9	9	0.0
49465	2005	9	10	0.0
49465	2005	9	11	2.8
49465	2005	9	12	0.2
49465	2005	9	13	0.0
49465	2005	9	14	60.6
49465	2005	9	15	0.0
49465	2005	9	16	5.8
49465	2005	9	17	13.0
49465	2005	9	18	14.4
49465	2005	9	19	1.2
49465	2005	9	20	0.0
49465	2005	9	21	5.4
49465	2005	9	22	0.6
49465	2005	9	23	7.0
49465	2005	9	24	4.6

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2005	9	25	2.6
49465	2005	9	26	0.0
49465	2005	9	27	0.0
49465	2005	9	28	0.0
49465	2005	9	29	0.0
49465	2005	9	30	0.0
49465	2005	10	1	2.4
49465	2005	10	2	0.0
49465	2005	10	3	0.0
49465	2005	10	4	0.0
49465	2005	10	5	13.6
49465	2005	10	6	44.0
49465	2005	10	7	8.4
49465	2005	10	8	0.0
49465	2005	10	9	22.8
49465	2005	10	10	0.2
49465	2005	10	11	2.0
49465	2005	10	12	0.4
49465	2005	10	13	17.0
49465	2005	10	14	4.6
49465	2005	10	15	0.4
49465	2005	10	16	36.6
49465	2005	10	17	0.0
49465	2005	10	18	1.8
49465	2005	10	19	4.2
49465	2005	10	20	3.2
49465	2005	10	21	0.0
49465	2005	10	22	2.2
49465	2005	10	23	0.2
49465	2005	10	24	0.8
49465	2005	10	25	2.2
49465	2005	10	26	14.0
49465	2005	10	27	11.8
49465	2005	10	28	2.0
49465	2005	10	29	0.2
49465	2005	10	30	1.6
49465	2005	10	31	14.0
49465	2005	11	1	0.0
49465	2005	11	2	17.0
49465	2005	11	3	0.0
49465	2005	11	4	0.0
49465	2005	11	5	46.6
49465	2005	11	6	13.8
49465	2005	11	7	0.8
49465	2005	11	8	0.4
49465	2005	11	9	0.6
49465	2005	11	10	0.6
49465	2005	11	11	2.4
49465	2005	11	12	0.0
49465	2005	11	13	13.6
49465	2005	11	14	0.0
49465	2005	11	15	0.0
49465	2005	11	16	0.0
49465	2005	11	17	1.6
49465	2005	11	18	6.6
49465	2005	11	19	150.2

Stnno	Year	Month	Day	Rainfall (08-08 MST) (mm)
49465	2005	11	20	134.2
49465	2005	11	21	84.6
49465	2005	11	22	295.4
49465	2005	11	23	54.4
49465	2005	11	24	0.0
49465	2005	11	25	0.2
49465	2005	11	26	4.0
49465	2005	11	27	87.4
49465	2005	11	28	4.0
49465	2005	11	29	13.6
49465	2005	11	30	0.0
49465	2005	12	1	1.8
49465	2005	12	2	12.6
49465	2005	12	3	0.0
49465	2005	12	4	2.4
49465	2005	12	5	59.2
49465	2005	12	6	2.2
49465	2005	12	7	0.4
49465	2005	12	8	0.2
49465	2005	12	9	0.4
49465	2005	12	10	0.4
49465	2005	12	11	0.2
49465	2005	12	12	10.2
49465	2005	12	13	0.4
49465	2005	12	14	24.6
49465	2005	12	15	3.2
49465	2005	12	16	132.2
49465	2005	12	17	190.8
49465	2005	12	18	86.6
49465	2005	12	19	1.2
49465	2005	12	20	0.0
49465	2005	12	21	1.4
49465	2005	12	22	21.0
49465	2005	12	23	11.2
49465	2005	12	24	47.8
49465	2005	12	25	40.2
49465	2005	12	26	5.2
49465	2005	12	27	0.6
49465	2005	12	28	0.0
49465	2005	12	29	0.2
49465	2005	12	30	0.0
49465	2005	12	31	15.0
			Total	13480.0
			Average	7.4 mm/day
				0.3 mm/hr
				0.012 inch/hr
				2694.5 mm/yr

Note : MST - Malaysian Standard Time
Definition : -33.3 - Trace (Rainfall amount less than 0.1 millimetre)

The daily rainfall amount (0800 - 0800 MST) for a particular day is the amount collected over the 24 - hour period beginning from 0800 a.m. on that day. For example, the daily rainfall amount for 25th. December, 2004 is the amount collected over the 24 - hour period from 0800 a.m. 25th. December, 2004 to 0800 a.m. 26th. December 2004.

Appendix G

Computation Of Remedial Alternatives Quantities

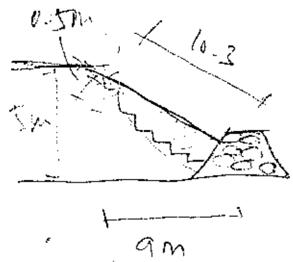
OPTION A - COSMIC ACCORD

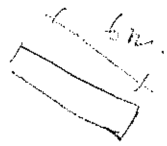
BILL OF QUANTITIES

Item	Description	Unit	Quantity
	Toe Drain		926
1.01	Rockfill maximum size 200mm	m3	3,826
1.02	Wrapped around with terram 100 geotextile filter material or equivalent	m2	12,585
1.03	Backfilling with suitable material	m3	4,769
1.04	Turf mattress secured by U-shaped staples	m2	5,556
1.05	Closed turfing	m2	5,556
1.06	Sealing of gap with sand	m3	556

Taking-off Sheet

Project:	Sheet:

			Rock fill maximum size [illegible] mixed with [illegible] suitable fill material [illegible]
2/	463	926	length = 463 both sides
			Backfilling with suitable material 
2/	0.15 10.3 463	4769	appx = 10.3 × 1 both sides. length = 463.

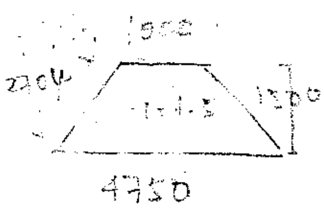
			Turfi Mattress secured by U-shaped stakes 
2/	6 463	5556	length 463
			Closed turfing. ditto.
2/	6 463	5556	
			Sealing of gap with sand.
2/	6 463 0.1	556	depth = 0.5m

Taking-off Sheet

Sheet:

Toe Berm

Type 1



Rockfill max size 2000 mm

Area = $\frac{1}{2}[1+4.75]1.5$
= 3.56 m^2

length = 26325 - 26625
= 300 m

Volume = 3.56 × 300
= 1069 m^3

Both sides = 2138 m^3

Geotextile

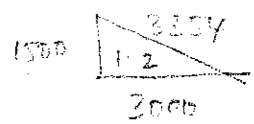
P = 1 + 4.75 + 2.704 + 2.704
= 11.158 m

length = 300 m

Both Sides

Area = 11.158 × 300 × 2
= 6694.8 m^2

Type 2 & 3



Rockfill

Area = $\frac{1}{2}[3 \times 1.5]$ = 2.25 m^2

length = (26800 - 27000) + (26800 - 26625)
= 375 m

Both sides

Volume = 2.25 × 375 × 2
= 1687.5 m^3

Geotextile

P = 1.5 + 3 + 3.354
= 7.854 m

length = 375 m

Both Sides

Area = 5890.5 m^2

Total Rockfill

2138 + 1687.5 = 3826 m^3

Total Geotextile

6694.8 + 5890.5 = 12585.3 m^2

) LEVEL

FAISAL,ABRAHAM dan AUGUSTIN Sdn.Bhd.

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ESA SRI HARTAMAS,
)480, KUALA LUMPUR.
l No. : 03 - 23006699, 03 - 23006688
x No. : 03 - 23008686

(UANTAN - KERTEH RAILWAY PROJECT

RECTIFICATION WORKS -SHEET 2
(CH 26325.00m TO CH 27000.00m)
OPTION A

S JASM			
AL	DISEMAK OLEH: Dr. FAISAL	DRAWING NO.	REV.
FAISAL			

TO E

ROCI WRAPPED
AROUN GEOTEXTILE
LENT

GROUND LEVEL

CONSTRUCTION SEQUENCE

. ON ANY CROSS SECTION THE RECTIFICATION WORKS SHOULD C ONE SIDE OF THE EMBANKMENT ONLY.
. INSTALL TEMPORARY SHEET PILE WALL.
. REMOVE THE SLIPPED LOOSE OR SOFT UNSUITABLE MATERIAL.
. START BENCHING AS SHOWN ABOVE.
. BASE OF ROCKFILL TO BE CHECKED AND APPROVED PRIOR TO OF ROCKFILL.
. ROCKFILL TOE WRAPPED AROUND BY GEOTEXTILE.
. PROGRESSIVE LAYERS OF SUITABLE FILL MATERIAL TO REQUIRE
. TRIM THE SLOPE & INSTALL TURF MATTRESS TO MANUFACTURI UP TO SHEET PILE.
. CLOSE TURFED.
0. REMOVAL OF SHEET PILE PRIOR TO CONSTRUCTING SHEET PILE OPPOSITE SIDE OF THE EMBANKMENT.
1. AFTER REMOVAL SHEET PILE ANY GAP TO BE SEALED WITH SA TO BE RECONSTRUCTED AND COMPLETED AS PER ITEM 7 ABO

F SHEET PILE TO MAINTAIN THE TRACK LEVELS AND TO REINSTATE TO ORIGINAL LEVELS.
TAKE A RIGOROUS DAILY MONITORING OF LEVELS AND MIT IT FOR REVIEW.
TAKE DUE DILIGENCE DURING THE EXTRACTION OF SHEET PILES TO AVOID EXCESSIVE SETTLEMENT AS HE SPECIFICATION.

OUND LEVEL

FAISAL,ABRAHAM dan AUGUSTIN Sdn.Bhd.

No. 20-3, JALAN 28/70A,
DESA SRI HARTAMAS,
50480, KUALA LUMPUR.
Tel No. : 03 - 23006699, 03 - 23006688
Fax No. : 03 - 23008686

JANTAN - KERTEH RAILWAY PROJECT

ECTIFICATION WORKS - SHEET 1
26325.00m TO CH 27000.00m)
OPTION A

RIS JASIM			
MAL	DISEMAK OLEH: Dr. FAISAL	DRAWING NO.	REV.
. FAISAL			

OPTION B - OGP

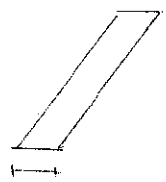
BILL OF QUANTITIES

Item	Description	Unit	Quantity
	1m thick approved frictional cohesive fill wih 2 layers of tensar BX1 geogrid at 0.5m spacing.		
1.01	Cohesive fill	m3	3,704
1.02	Tensar BX1 Geogrid	m2	7,408
1.03	500m thick compacted sand base layer	m2	3,704
1.04	1000m x 500mm thick compacted sand drainage strip at 0.5 m spacing	m3	309
1.05	600mm thick wall with 200m down granite rock fill with 1:3 cement sand mortar.	m	926
1.06	300mm cube gravel fill with 75mm dia. UPVC weep holes at 2m c/c pipe to be wrapped with filter membrane on unexposed side	nos	932
1.07	Tensar BX1 geogrid at 0.5m spacing	m2	9,158
1.08	Tensar UX1 geogrid at 0.5m spacing	m2	11,931
1.09	Well compacted approved frictional cohesive fill	m3	6,172
1.10	Closed turfing	m2	8,334
	French Drain		
1.11	20mm single size aggregate wrapped with geotextile with 100mm dia. Perforated pipe wrapped with geotextile	m	564
1.12	600mm wide x 300mm deep Berm Drain	m	926
1.13	Cascade Drain	m	54
1.14	0.9m X 0.9m Sump	nos	9
1.15	200mm Mortar Slope apron underlaid with filter membrane	m2	6

Taking-off Sheet

Sheet: 1

			1m thk approved frictional cohesive fill with 2 layers of tensar BX1 Geogrid at 0.5 spacing
			Cohesive fill
			width = 4m length = 463 m both side east & west
2/	4 463	3704	
			Tensar BX1 Geogrid
2/2/	4 463	7408	width = 4m length = 463 m both side 2 layer..

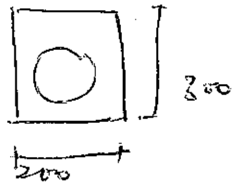
			500 mm thk. compacted sand base layer
2/	4 463	3704	width : 4m length = 463 both side.
			1000 mm x 500 mm thk compacted sand drainage strip at 5.0m spacing
			 500 mm
2/	1 0.5 309	309	length = 463 m spacing 5.0m Nos = 309 legth of each = 1m thickness = 0.5m

462.5 / 925

Taking-off Sheet

Project:
Construction of infrastructure and foundation for Thermal Storage Tank, Gas District Cooling System, in Universiti Teknologi PETRONAS

Sheet: 2

			Retaining Wall				French Drain
			600 mm thick wall with 300 mm down granite rock fill with 1:3 cement sand mortar.				
	2/	463	length = 463 both sides				No. of Drain $\frac{463}{5}+1=94$
		926			2/	.94 3	both sides length = 3 m
						564	
			300 mm cube gravel fill with 75mm Ø uPVC weep holes at 2m c/c pipe to be wrapped with filter ~~material~~ membrane on, unexposed side				
			Nos of cube $= (463/2)+1$ $= 233$ nos				
	2/2/	233					
		932	2 layers, both sides				

Taking-off Sheet

Sheet: 3

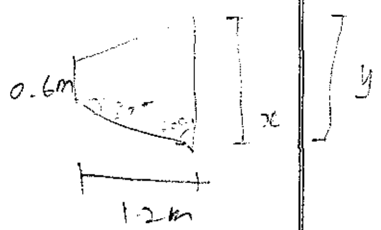
			<u>Geogrid</u>. (Detail A).
			1m length Tensar BX1 Geogrid at 0.5m spacing
	1		
	4114		length = 4114 m
	4114		width = 1m.
			Tensar UX1 Geogrid at 0.5 m Spacing.
	2.9		length = 4114 m
	4114		width = 4 - 0.6 - 0.5
	11931		= 2.9 m.
			<u>Geogrid (Detail B).</u>
			Tensar BX1 Geogrid at 0.5 Spacing.
	1		length = 5044 m.
	5044		Ave. Width = 1 m.
	5044		
			<u>Total</u>
			BX1 = 9158 m^2
			UX1 = 11931 m^2
			refer computation.

			<u>Backfilling</u>
			Well compacted approved frictional cohesive fill.
			refer computation
			Total backfill
			= 6172 m^3
			<u>Turfing</u>
			width m
			
			total = 9 m.
2/	9		length = 463 m
	463		both sides.
	8334		

Taking-off Sheet

Project:

Sheet:

			<u>Drainage</u>
			600mm wide x 300mm deep Berm Drain
2/	463		length = 463 m Both sides
		926	
			600mm wide cascade drain.
9/	6		length = 6m. (avg) nos = 9
		54	
			0.9x0.9m Sump
			nos = 9.
	9		
			200mm Mortar Slope apron underlaid with filter membrane.
			nos = 9.
			
			$\tan 30° = \frac{x}{1.2}$
			$x = 0.69$ m
			$y = 0.69 + 0.69 + 0.6$ $= 1.98$ m
			<u>Area =</u> $\frac{1}{2}(0.6)(1.98)(1.2)$
9/	0.71		$= 0.71$ m2.
		6.42	

Section	Chainage	Distance	Right				Left			
			Height	nos of layers	Ave	Total Length	Height	nos of layers	Ave	Total Length
A	26337		2.831	5.662			2.745	5.49		
		88			5.236	460.768			5.441	478.808
B	26425		2.405	4.81			2.696	5.392		
		75			4.484	336.3			5.255	394.125
C	26500		2.079	4.158			2.559	5.118		
		75			4.304	322.8			4.539	340.425
D	26575		2.225	4.45			1.98	3.96		
		75			4.479	335.925			3.91	293.25
E	26650		2.254	4.508			1.93	3.86		
		75			4.1	307.5			3.961	297.075
F	26725		1.846	3.692			2.031	4.062		
		75			3.572	267.9			3.728	279.6
G	26800		1.726	3.452			1.697	3.394		
						2031.193				2083.283

Total length BX1 = 2031 + 2083 = 4114 m
Total length UX1 = 2031 + 2083 = 4114 m

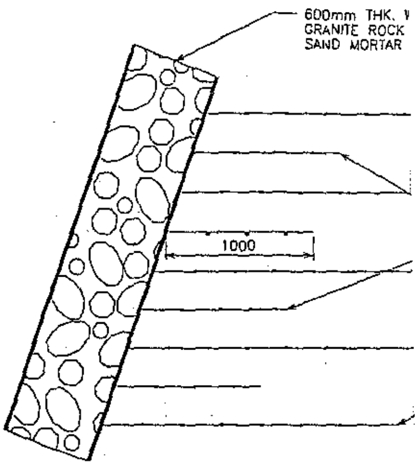
Geogrid (Detail B) - Tensar BX1 Geogrid at 0.5 spacing

Section	Chainage	Distance	Right				Left			
			Height	nos of layers	Ave	Total Length	Height	nos of layers	Ave	Total Length
A	26337		2.831	6.662			2.746	6.492		
		88			6.236	548.768			6.442	566.896
B	26425		2.405	5.81			2.696	6.392		
		75			5.484	411.3			6.254	469.05
C	26500		2.079	5.158			2.558	6.116		
		75			5.304	397.8			5.538	415.35
D	26575		2.225	5.45			1.98	4.96		
		75			5.481	411.075			4.911	368.325
E	26650		2.256	5.512			1.931	4.862		
		75			5.103	382.725			4.98	373.5
F	26725		1.847	4.694			2.049	5.098		
		75			4.572	342.9			4.746	355.95
G	26800		1.725	4.45			1.697	4.394		
						2494.568				2549.071

Total length BX1 = 2495 + 2549 = 5044 m

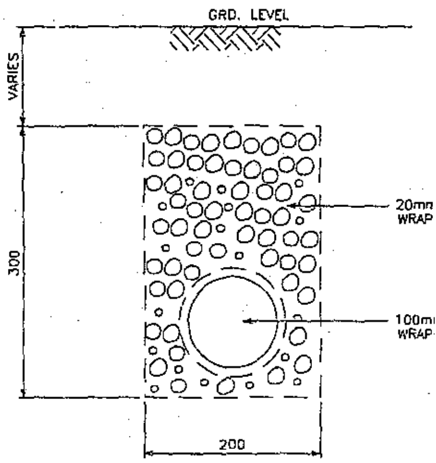
Section	Chainage	Distance	Right				Left			
			Height	Width	Area	Volume	Height	Width	Area	Volume
A	26337		2.831	3	8.493		2.745	3	8.235	
		88				691				718
B	26425		2.405	3	7.215		2.696	3	8.088	
		75				504				591
C	26500		2.079	3	6.237		2.559	3	7.677	
		75				484				511
D	26575		2.225	3	6.675		1.98	3	5.94	
		75				504				440
E	26650		2.254	3	6.762		1.93	3	5.79	
		75				461				446
F	26725		1.846	3	5.538		2.031	3	6.093	
		75				402				419
G	26800		1.726	3	5.178		1.697	3	5.091	
						3047				3125

Total Volume = 6,172 m3



DETAIL "A"

SCALE : NTS



DETAIL 'D'

N.T.S.

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	REVISION		
).05	ISSUED FOR BIDDING	RRA	AR
).05	ISSUED FOR IDC	RRA	AR
E	DESCRIPTION	--	

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PETRONAS ASSETS

PETRONAS ASSETS SDN BHD

Level 57, Tower 1,
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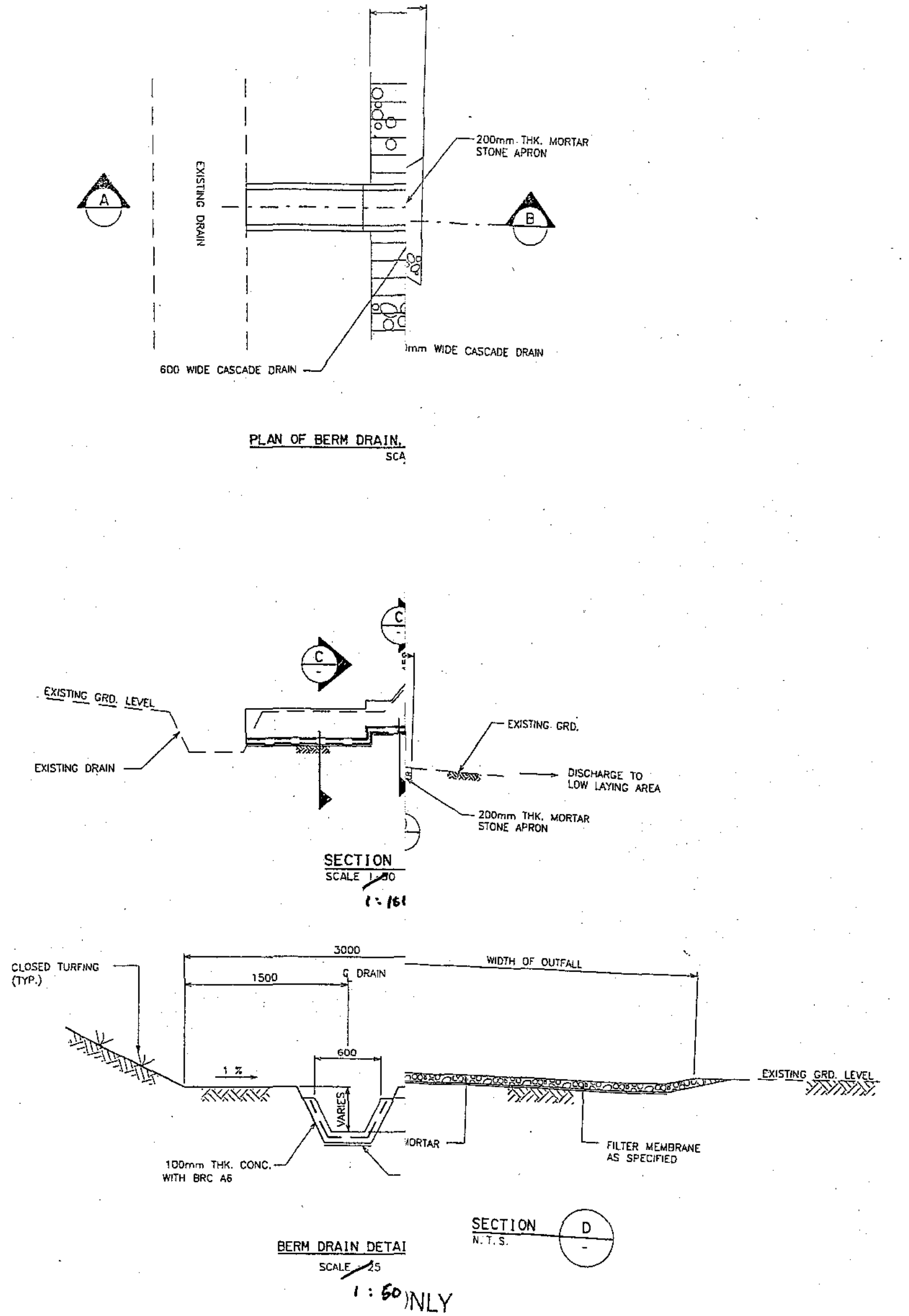
50088 Kuala Lumpur, Malaysia.

KUANTAN - KERTEH RAILWAY PROJECT - RECTIFICATION WORKS (PACKAGE 1)

CH. 26500 FAILED SLOPE

DETAILS 'A', 'B', 'C' AND 'D'



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NOTES:

FOR GENERAL NOTES REFER DWG. NO. 4104840-CV-00-001

	REVISION		
31.10.05	ISSUED FOR BIDDING	RRA	AR
11.10.05	ISSUED FOR IDC	RRA	

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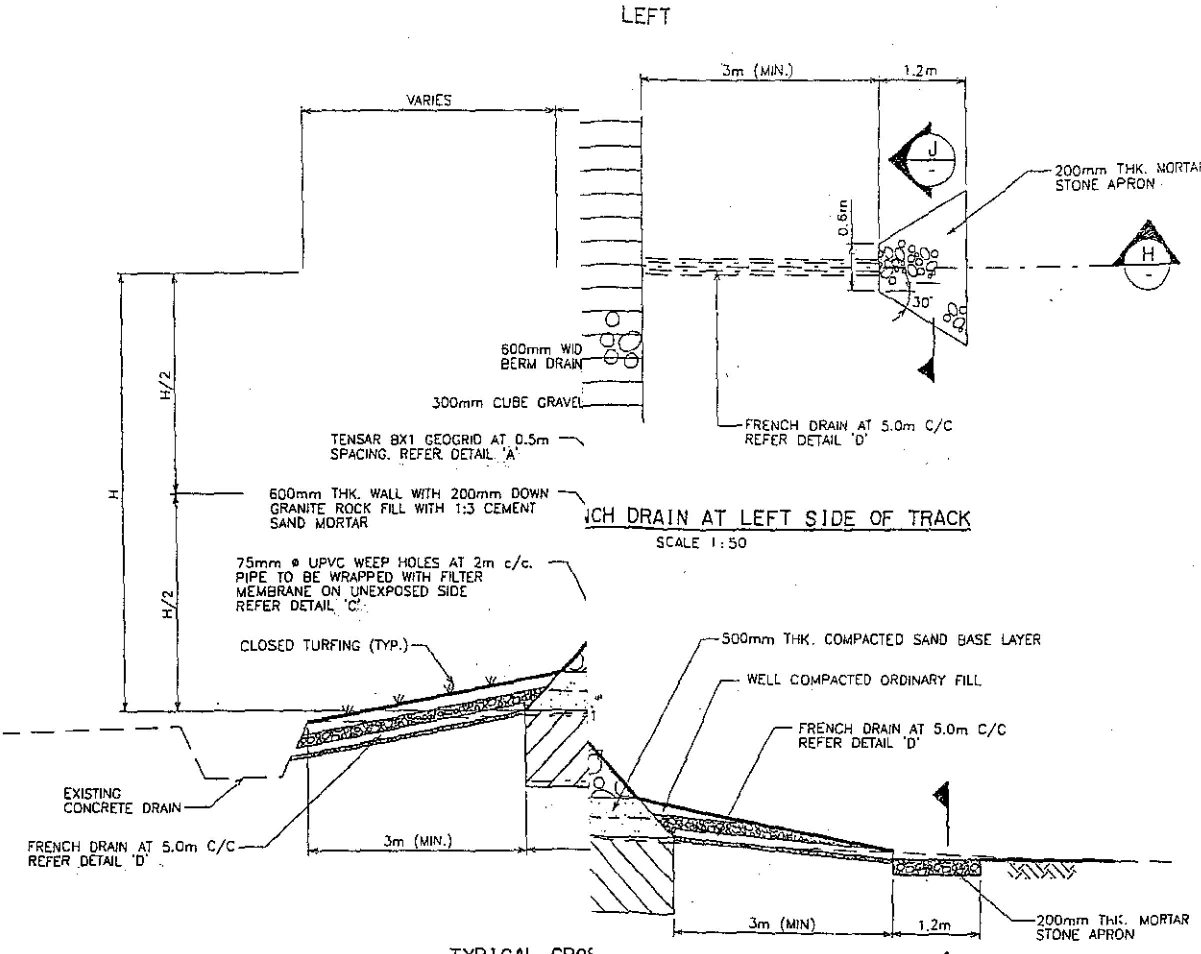
KUANTAN - KERTEH RAILWAY PROJECT - RECTIFICATION WORKS (PACKAGE 1)

CH. 26500 FAILED SLOPE

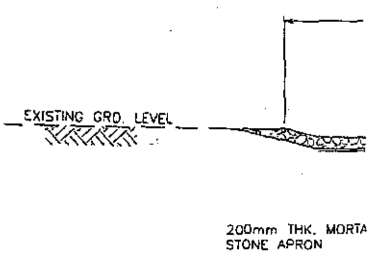
DETAILS OF MISCELLANEOUS DRAINAGE WORKS



ICH DRAIN AT LEFT SIDE OF TRACK
SCALE 1:50

TYPICAL CROS

SECTION H/010
SCALE 1:100



SITE CONTROL

TURFING

Turfing shall be close turf and placed immediately upon completion of the slope and in a manner as shown in the drawings. Turf shall be well water until they are established.

DRAINAGE

All drainage, including, berm drain, cascading step drain and toe drain shall be constructed in accordance with the drawings and shall be suitably laid to ensure effective drainage to outfall.

SPECIALIST WORK

Contractor shall engage specialist subcontractor with not less than 10 years experience for all specialist works.

DESIGN CRITERIA

1. Design strength of TENSAR geogrid material shall have a design life of 120 years at 30°c.
2. Global slope stability shall not be less than 1.25
3. Local slope stability shall not be less than 1.20
4. Internal stability of geogrid block shall not be less than 1.35
5. Stability of geogrid block against sliding shall not be less than 1.50
6. Design rainfall data shall be based on 1992 – 2003 record or other known worst condition.

CONSTRUCTION SAFETY

Contractor shall ensure safety of work at all times.

METHOD STATEMENT

Contractor shall submit method statement of work and obtain Engineer's Approval before commencement of work.

REVISION			
0.05	ISSUED FOR BIDDING	RRA	AR
0.05	ISSUED FOR IDC	RRA	AR
TE	DESCRIPTION		

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KUANTAN – KERTEH RAILWAY PROJECT – RECTIFICATION WORKS (PACKAGE 1)

CH. 26500 FAILED SLOPE

CROSS SECTIONS AND DETAILS

FENCE

3.451m

DATUM R.L. = 0.00m

EXISTING GROUND LEVEL (m)	3.004
DISTANCE (m)	18.260

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REVISION			
		RRA	AR
.10.05	ISSUED FOR BIDDING	RRA	AR
.10.05	ISSUED FOR IDC	RRA	AR
DATE	DESCRIPTION	DRN.	CHKD.

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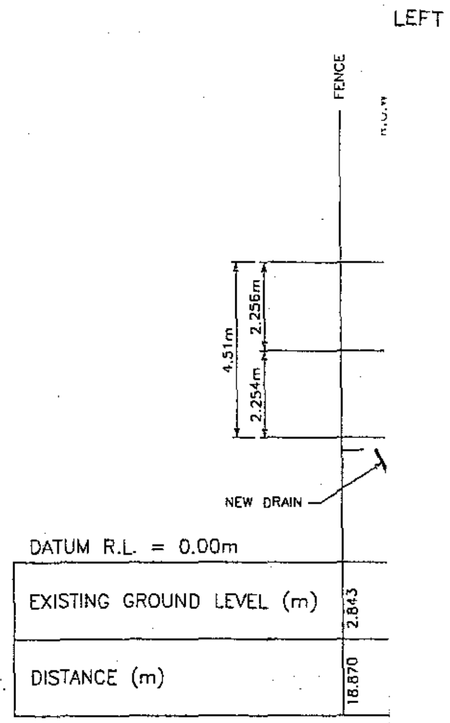
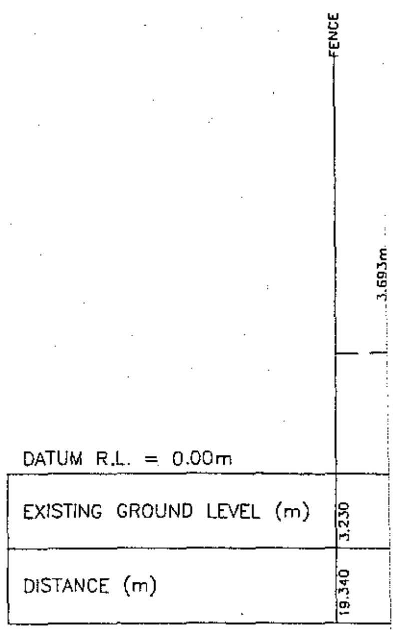
CH. 26500 FAILED SLOPE

CROSS SECTION

SCALE | DRAWING NO





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REVISION			
1. 10. 05	ISSUED FOR BIDDING	RRA	AR
5. 10. 05	ISSUED FOR IDC	RRA	AR

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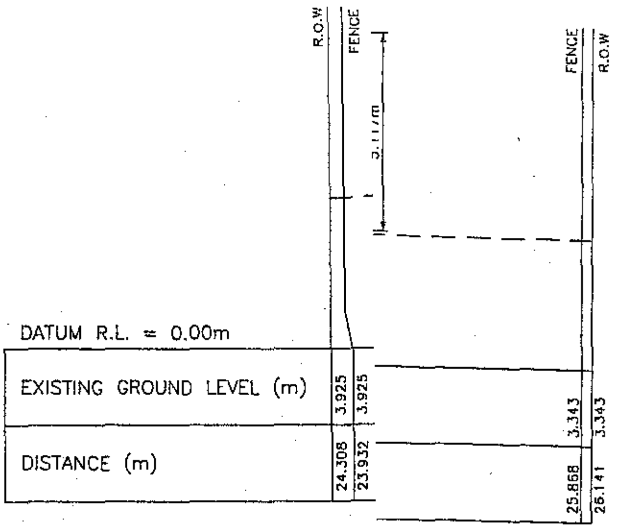
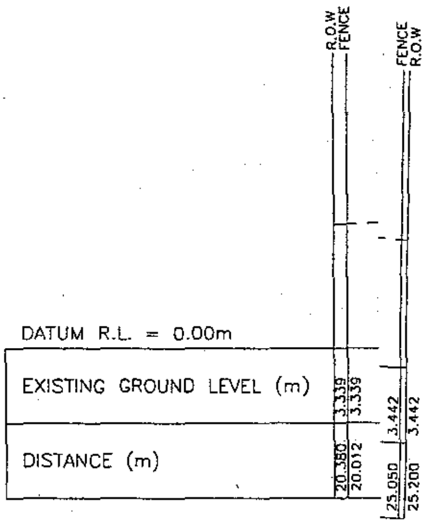
CH. 26500 FAILED SLOPE

CROSS SECTIONS

LEFT





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REVISION			
1. 10. 05	ISSUED FOR BIDDING	RRA	AR
6. 10. 05	ISSUED FOR IDC	RRA	AR

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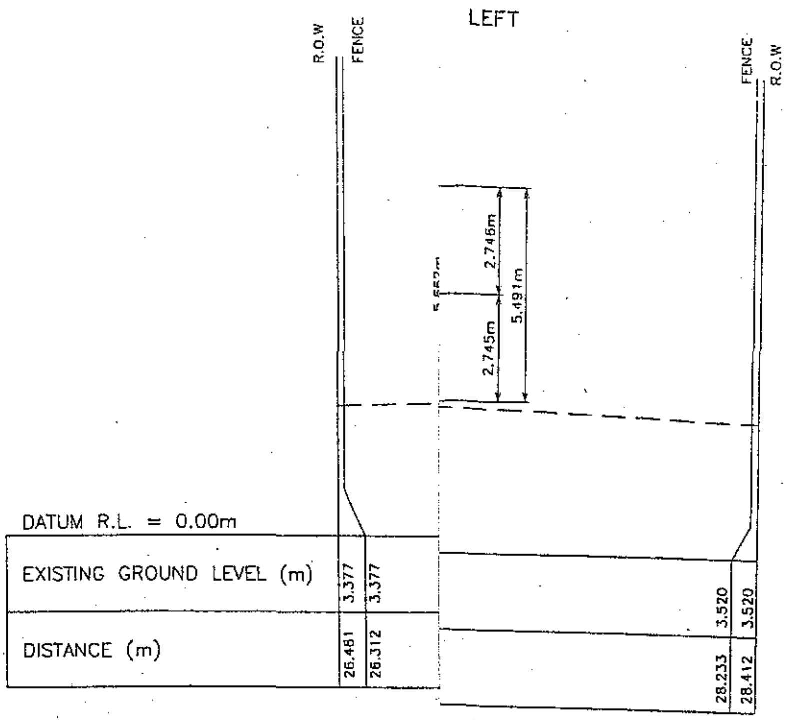
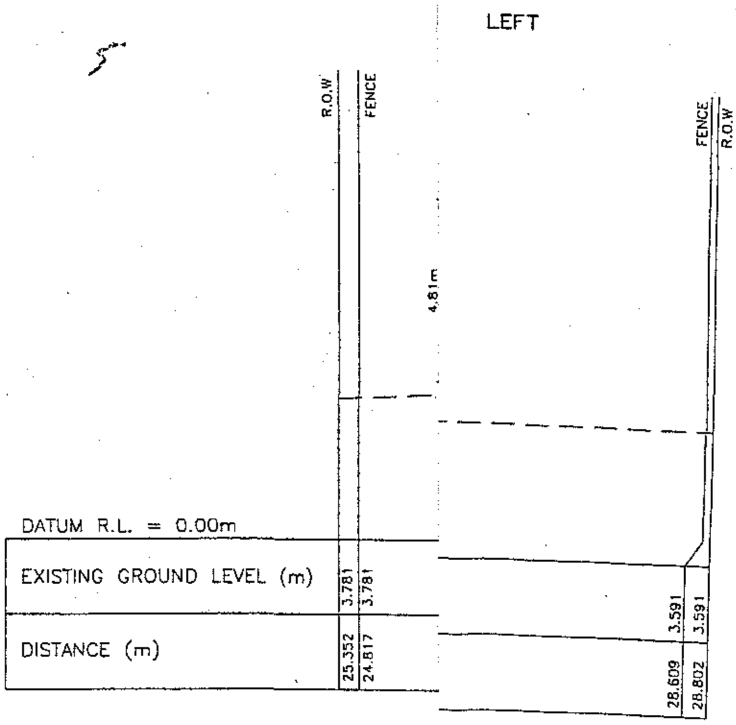
CH. 26500 FAILED SLOPE

CROSS SECTIONS





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REVISION			
.1 10.05	ISSUED FOR BIDDING	RRA	AR
6.10.05	ISSUED FOR IDC	RRA	AR

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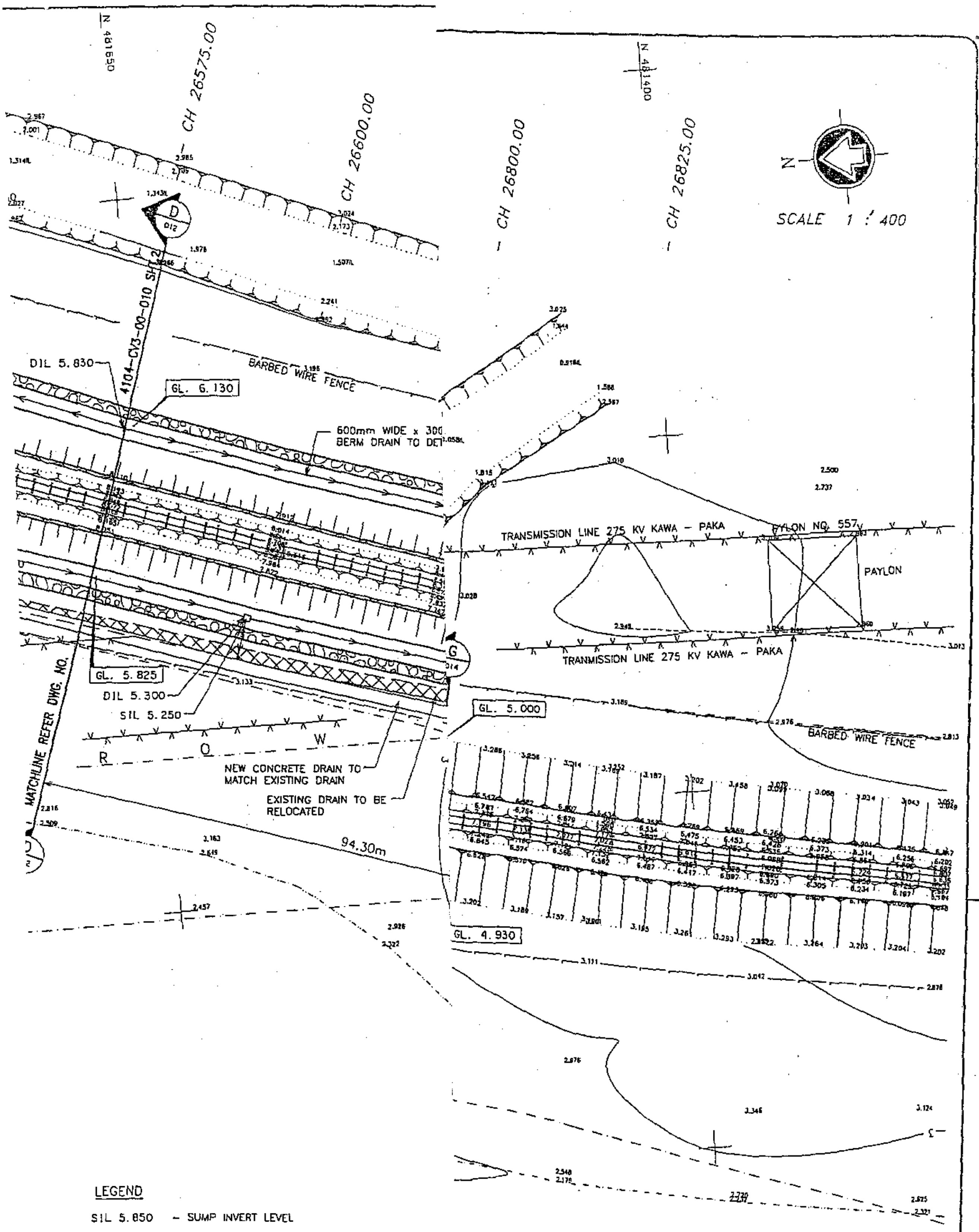
CH. 26500 FAILED SLOPE

CROSS SECTIONS



LEGEND

SIL 5.850	– SUMP INVERT LEVEL
DIL 5.900	– DRAIN INVERT LEVEL
++++++++	– 600mm WIDE CASCADING DRAIN
——←——	– 600mm WIDE BERM DRAIN
GL. 6.414	– GRADE LEVEL

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REVISION		
05 ISSUED FOR BIDDING	HRA	AR
05 ISSUED FOR IDC	RRA	AR
DESCRIPTION		

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KUANTAN - KERTEH RAILWAY PROJECT - RECTIFICATION WORKS (PACKAGE 1)

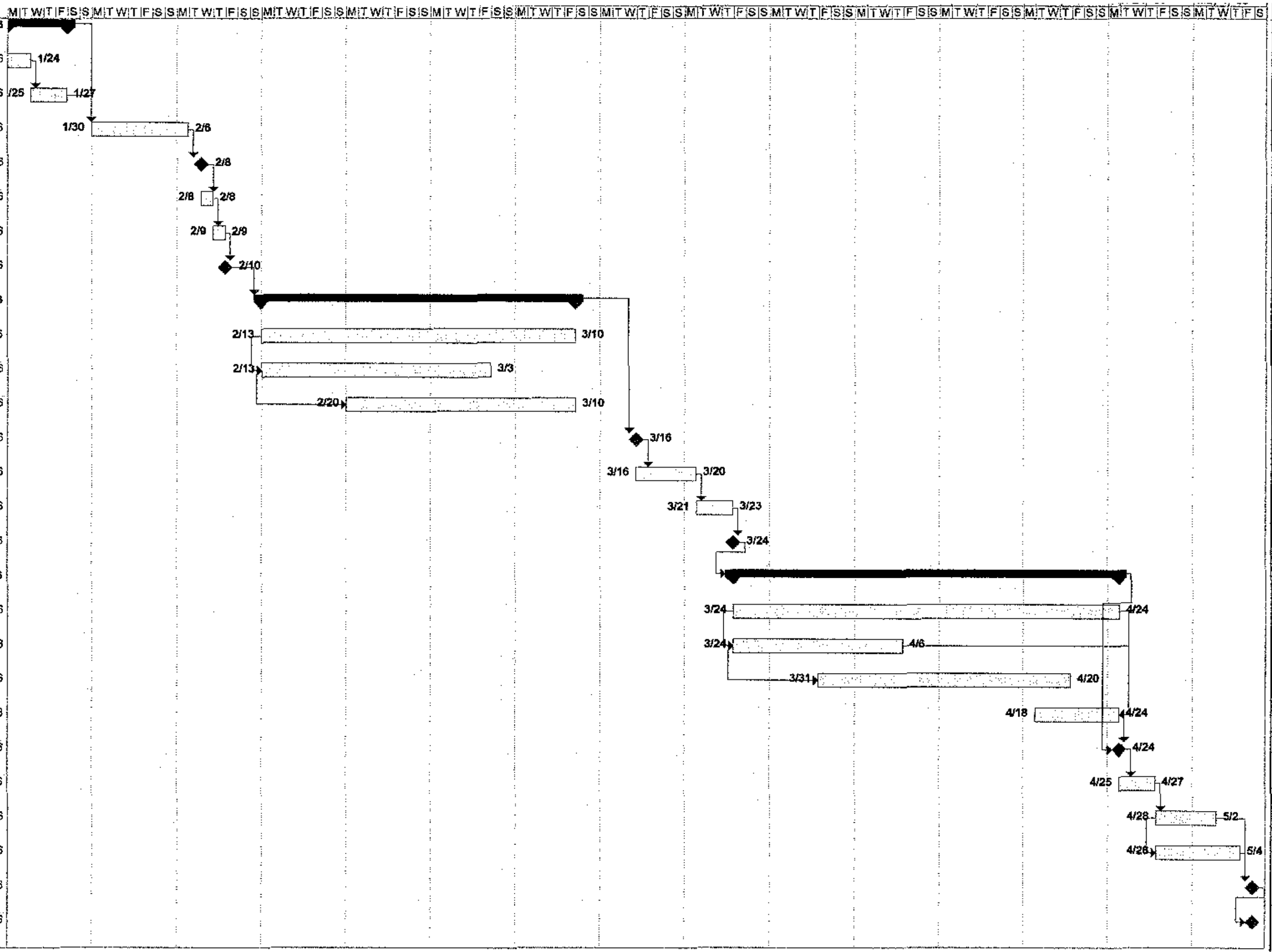
CH. 26500 FAILED SLOPE

PLAN

Appendix H

Gantt Chart

ID	Task Name	Duration	Start	Finish
1	**Selection of Project Title**	5 days	Mon 1/23/06	Fri 1/27/06
2	Propose Topic	2 days	Mon 1/23/06	Tue 1/24/06
3	Topic assigned to students	3 days	Wed 1/25/06	Fri 1/27/06
4	**Preliminary Research Work**	6 days	Mon 1/30/06	Mon 2/6/06
5	Submission of Preliminary Report-Draft	0 days	Wed 2/8/06	Wed 2/8/06
6	**Review by Supervisor**	1 day	Wed 2/8/06	Wed 2/8/06
7	**Amendment of Preliminary Report**	1 day	Thu 2/9/06	Thu 2/9/06
8	Submission of Preliminary Report-Amended	0 days	Fri 2/10/06	Fri 2/10/06
9	**Project Work**	**20 days**	**Mon 2/13/06**	**Fri 3/10/06**
10	Literature review	20 days	Mon 2/13/06	Fri 3/10/06
11	Collection/Acquisition of Data & Information	15 days	Mon 2/13/06	Fri 3/3/06
12	Data Review/Analysis	15 days	Mon 2/20/06	Fri 3/10/06
13	Submission of Progress Report-Draft	0 days	Thu 3/16/06	Thu 3/16/06
14	**Review by Supervisor**	3 days	Thu 3/16/06	Mon 3/20/06
15	**Amendment of Progress Report**	3 days	Tue 3/21/06	Thu 3/23/06
16	Submission of Progress Report-Amended	0 days	Fri 3/24/06	Fri 3/24/06
17	**Project Work continue**	**22 days**	**Fri 3/24/06**	**Mon 4/24/06**
18	Literature review	22 days	Fri 3/24/06	Mon 4/24/06
19	Collection/Acquisition of Data & Information	10 days	Fri 3/24/06	Thu 4/6/06
20	Initial design and construction analysis	15 days	Fri 3/31/06	Thu 4/20/06
21	Determination of failure(s) mode -Part I	5 days	Tue 4/18/06	Mon 4/24/06
22	Submission of Final Report-Draft	0 days	Mon 4/24/06	Mon 4/24/06
23	**Review by Supervisor**	3 days	Tue 4/25/06	Thu 4/27/06
24	**Amendment of Final Draft**	3 days	Fri 4/28/06	Tue 5/2/06
25	**Preparation for Oral Presentation**	5 days	Fri 4/28/06	Thu 5/4/06
26	Submission of Final Report to coordinator	0 days	Fri 5/5/06	Fri 5/5/06
27	Oral Presentation	0 days	Fri 5/5/06	Fri 5/5/06



Project: Final Year Project 1
Revision: Baseline

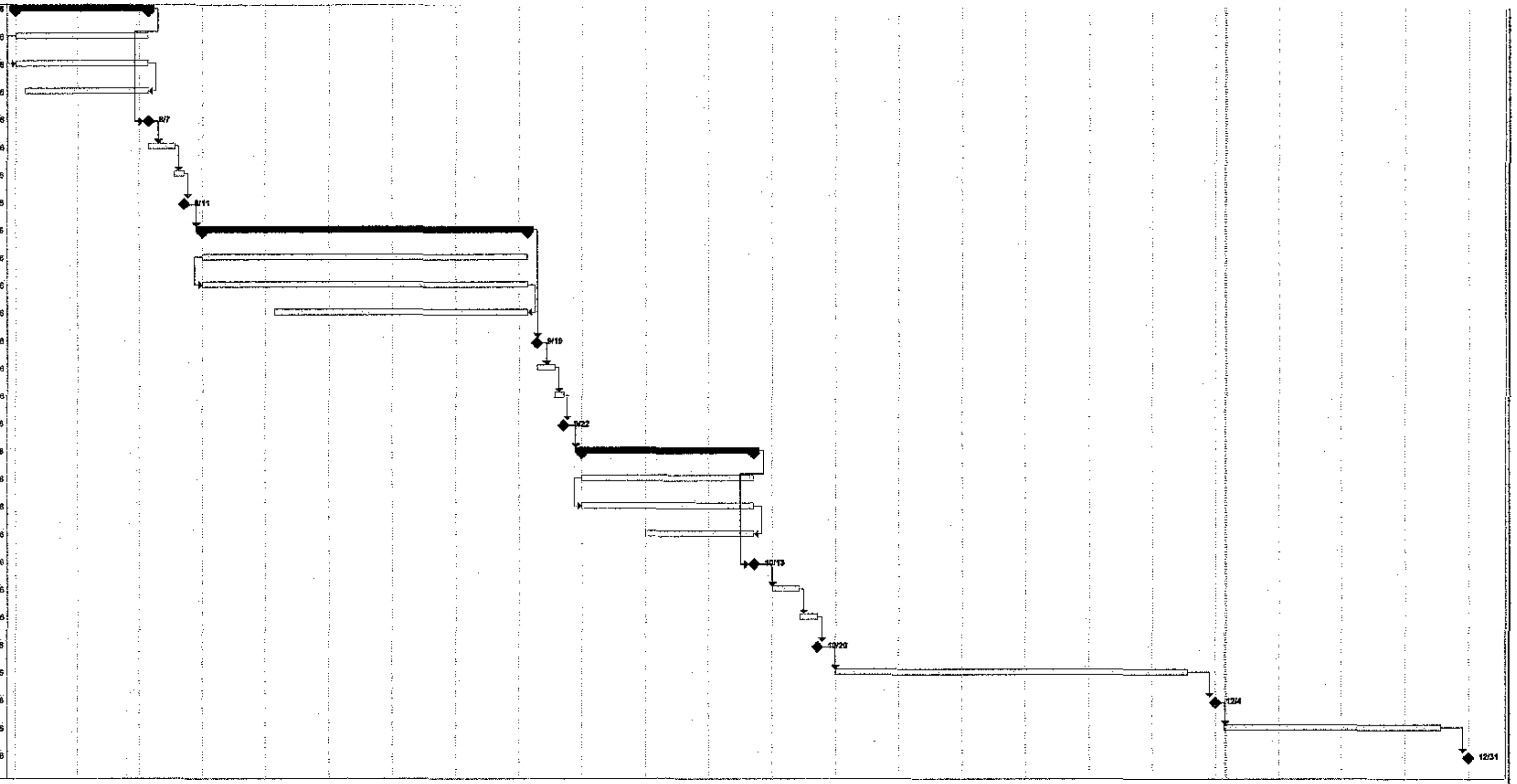
Task		Progress		Summary		Rolled Up Critical Task		Rolled Up Progress	
Critical Task		Milestone		Rolled Up Task		Rolled Up Milestone		Split	

External Tasks		Group By Summary
Project Summary		Deadline

Gantt Chart / Work Programme

Prepared by: Ho Siew Chen (5985)

ID		Task Name	Duration	Start	Finish
1		**Project Work continue**	**11 days**	**Mon 7/24/06**	**Mon 8/7/06**
2		Literature review	11 days	Mon 7/24/06	Mon 8/7/06
3		Collection/Acquisition of Data & Information	11 days	Mon 7/24/06	Mon 8/7/06
4		Determination of failure(s) mode -Part II	10 days	Tue 7/25/06	Mon 8/7/06
5		Submission of Progress Report 1 (SP)	0 days	Mon 8/7/06	Mon 8/7/06
6		Review by Supervisor	3 days	Tue 8/8/06	Thu 8/10/06
7		Amendment of Progress Report 1	1 day	Fri 8/11/06	Fri 8/11/06
8		Submission of Progress Report 1 (FYP Rep.)	0 days	Fri 8/11/06	Fri 8/11/06
9		**Project Work continue**	**21 days**	**Mon 8/14/06**	**Mon 9/18/06**
10		Literature review	21 days	Mon 8/14/06	Mon 9/18/06
11		Collection/Acquisition of Data & Information	21 days	Mon 8/14/06	Mon 9/18/06
12		Review, Suggest & Compare Corrective Actions	15 days	Tue 8/22/06	Mon 9/18/06
13		Submission of Progress Report 2 (SP)	0 days	Tue 9/19/06	Tue 9/19/06
14		Review by Supervisor	2 days	Wed 9/20/06	Thu 9/21/06
15		Amendment of Progress Report 2	1 day	Fri 9/22/06	Fri 9/22/06
16		Submission of Progress Report 2 (FYP Rep.)	0 days	Fri 9/22/06	Fri 9/22/06
17		**Project Work continue**	**15 days**	**Mon 9/25/06**	**Fri 10/13/06**
18		Literature review	15 days	Mon 9/25/06	Fri 10/13/06
19		Collection/Acquisition of Data & Information	15 days	Mon 9/25/06	Fri 10/13/06
20		Feasibility & Cost study	10 days	Mon 10/2/06	Fri 10/13/06
21		Submission of First Draft of Final Report (FYP Rep.)	0 days	Fri 10/13/06	Fri 10/13/06
22		Review by Supervisor	3 days	Mon 10/16/06	Wed 10/18/06
23		Amendment of Draft of Final Report	2 days	Thu 10/19/06	Fri 10/20/06
24		Submission of Final Draft of Final Report (FYP Rep.)	0 days	Fri 10/20/06	Fri 10/20/06
25		Preparation for Oral Presentation	29 days	Mon 10/23/06	Thu 11/30/06
26		Oral Presentation	1 day	Mon 12/4/06	Mon 12/4/06
27		Preparation of Hardbound Dissertation	18 days	Tue 12/5/06	Thu 12/28/06
28		Submission of Hardbound Dissertation (FYP Rep.)	0 days	Sun 12/31/06	Sun 12/31/06



Project: FYP2(rev1)
Date: Tue 12/5/06

Critical		Critical Progress		Split		Baseline		Baseline Milestone	◇	Summary Progress	
Critical Split		Task		Task Progress		Baseline Split		Milestone	◆	Summary	
Project Summary		External Milestone									
External Tasks		Deadline									

Revision 0

Prepared by: Ho Siew Chen (5985)